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of Engineers
Water Resources Support Center
Institute for Water Resources

THE 1988 INLAND WATERWAY REVIEW

NOVEMBER 1988

IWR Report 88-R-7

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188
Exp. Date: Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) IWR Report 88-R-7	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION USACE, Water Resources Support Center, Institute for Water Resources; 6b. OFFICE SYMBOL (If applicable) CEWRC-IWR-N	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Casey Building Ft. Belvoir, VA 22060-5586	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

THE 1988 INLAND WATERWAY REVIEW

12. PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
	FROM ____ TO ____	1988 November	378

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	U.S. Army Corps of Engineer, inland waterways; locks, navigation; ~~waterway type,~~ appropriations, expenditures; rehabilition; Channels waterways. (EDC)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report analyzes existing and prospective waterway traffic, system performance, the Corps of Engineers planning, design, construction & operation programs and the financial resources likely to be available in the near future from the Inland Waterway Trust Fund. The report emphasizes those inland waterway segments which are identified for fuel tax contributions to the Inland Waterways Trust Fund (about 11,000 miles of commercially significant waterways with 9 foot or greater depths. Keywords: Locks waterways; Water traffic; Regional planning, User needs/maintenance;

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL George Antle, Ph.D.	22b. TELEPHONE (Include Area Code) 202-355-2240; 22c. OFFICE SYMBOL CEWRC-IWR-N

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted

SECURITY CLASSIFICATION OF THIS PAGE

THE 1988 INLAND WATERWAY REVIEW

PREPARED BY

NAVIGATION DIVISION
INSTITUTE FOR WATER RESOURCES
WATER RESOURCES SUPPORT CENTER
U. S. ARMY CORPS OF ENGINEERS

NOVEMBER 1988

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLES

TABLES (Continued)

FIGURES

Page

Page

INTRODUCTION

The Institute for Water Resources (IWR) has been tasked by the Chief of Engineers to prepare an Inland Waterway Review which is designed to provide a 10-year outlook at the priority needs for planning, design, construction and operation of the Inland Waterways System. The objective of the Review is to provide an update of the National Waterways Study on an annual, or at least recurring, basis.

For numerous good reasons, Corps planning for waterway improvements is centered at the district and division level. Nationwide waterways studies have been infrequent. The predecessor of the 1982 National Waterways Study was the 1908 Inland Waterways Commission Report. Performed infrequently, nationwide studies require massive effort. Equally important, their findings go stale. The intent with the Waterway Review is to provide a lesser level of detail, but to make the information more timely and useful.

The tasking to produce a Waterway Review was timely. As a result of the Water Resources Development Act of 1986 (Pub. L.99-662) at least two crucial uses of the Review have been identified. The Act differentiates fuel-taxed waterways from all other navigation projects for application of study and construction cost-sharing. It also increased waterway fuel taxes and created the Inland Waterways Users Board. In effect, the Act defined the waterways system, and created a demand for its analysis as a system.

The increase in waterway fuel taxes increased the pressures to accelerate project implementation. Among the Corps initiatives to do so, the Task Force to Streamline Project Implementation identified a need to coordinate the waterways planning of the several divisions involved. It identified the Waterway Review as a device to harmonize the assumptions and analyses of the various divisions, so that their regional plans can be integrated and used as a system plan.

The other crucial use of the Review is to provide a decision tool for the Inland Waterways Users Board. The Board's Congressional mandate is to recommend priorities for construction and rehabilitation of improvements on the waterways system. The Board's recommendations are based on the collective, independent judgements of its members. For that purpose they have used a predecessor document called Status of the Inland Waterways, July 1987, and have identified a continuing need for a reference such as the Review.

The need for project-specific feasibility studies is imbedded in legislation and the process for authorizing and funding improvements. The purpose of the Review is not to replace or reduce those planning efforts, but to supplement and make them more useful. The Review is a system outlook or overview. It is not a system plan.

OVERVIEW

REVIEW FOCUS

The Plan of Study for the Inland Wat· ·· / Review calls for systematic analysis of existing and prospective:

- o traffic levels
- o system performance
- o transportation savings
- o investment needs, and
- o financial resource availability for waterways investment

This Review addresses all of the above subjects to some extent. It does not provide equally comprehensive treatment of every subject in order to focus on information or analyses for which there is immediate need. The intent is to treat each subject in depth over time, in subsequent editions of the Review.

REVIEW HIGHLIGHTS

One immediate need was consistency in the assumptions and analyses used in waterways planning by the various Corps elements. Jurisdiction over the waterways in the fuel-taxed system is distributed over eight Corps divisions. The Lower Mississippi Valley, Missouri River, North Central, North Pacific, Ohio River, South Atlantic, and Southwestern divisions are responsible for virtually all system planning, with a small portion of the Atlantic Intracoastal Waterway extending into North Atlantic jurisdiction. Each of these divisions has a budget strategy for meeting the improvement needs of the system. Their regional or waterway subsystem plans vary greatly in level of detail and sophistication.

There is a need for greater uniformity in the regional plans if they are to be viewed collectively to identify system needs and priorities. Particularly in estimates of traffic or demand and lock capacity. Historically it has been most difficult to produce consistency in traffic projections, where nationwide studies disaggregate national trends, and regional or project-specific studies reflect local knowledge. This is the problem addressed in this review. The solution was to abandon the use of a single target trend for each individual waterway based on the national trend. Instead, the Review has established a high-low band for each waterway on a scientific basis that allows for differential growth, and should produce rational results when regional projections are combined or compared. This procedure is described more fully in Appendix A.

The integration of national and regional traffic projections is a significant achievement. It was also very difficult, and made this Review less timely for its other immediate need -- an updated reference for the Inland Waterways Users Board. Primarily the Board's members want the Review for the latest trends and performance statistics, to verify their personal knowledge of problems on the system and support the priorities they assign to waterway improvements. In addition, they look to the Review for an early indication of capacity constraints, in order to verify that the Corps planning program has studies underway that will produce timely recommendations, so that the priority projects can be implemented in proper sequence.

Because the Users Board members are familiar with the waterways, they can interpret the

summary data in Appendix A, and it alone is useful. This is supplemented by the information shown in the Main Report's Chapters, some of which address specific needs or concerns of the Board. Its members have used previous iterations of the analysis of Inland Waterways Trust Fund revenues and outlays shown in Chapter 5 as a tool in assigning priorities to waterway improvements. They recognize it would be desirable to use definitive studies as the basis for their decision making -- also that some alternative is required to assess the adequacy of the Corps planning process to produce the right projects at the right time. It has been suggested that the Board explore use of performance indicators for that purpose. Chapter 3 is an initial effort to manipulate PMS data to identify priorities and the benefits of potential improvements.

REVIEW CONTENTS

This Review consists of a Main Report and two appendices. The stated purposes of the Review generally coincide with the five chapters in the Main Report, but not all purposes are treated in separate chapters. The five chapters and the subjects covered are as follows:

1. Physical System. This chapter is a necessary preface to addressing the stated purposes of the Review. It describes both the fixed plant (locks and waterways) and the vessel fleet.

2. Inland Waterway Traffic: Historic Trends and Projections. This chapter provides a national perspective of the composition and levels of waterway commerce. The integration with regional studies is covered in Appendix A.

3. Performance of Locks. This chapter uses Performance Monitoring System (PMS) data for a preliminary analysis of system performance and transportation savings. An estimate of system benefits is a purpose of the Review that will be addressed in the future.

4. Program Review. This chapter identifies waterway improvements under construction and study, and provides a preliminary identification of improvement alternatives in lieu of a needs assessment. A comprehensive assessment of needs is reserved to the future, and any interim assessment will be a separate document.

5. Status of the Inland Waterways Trust Fund. This chapter provides an estimate of the financial resources available from fuel taxes and interest earnings on the fund balances, to fund the investment needed for improvements under construction or study.

Appendix A provides detailed descriptions of nine waterway segments, with traffic history and projections and performance indicators. Appendix B describes the environmental impact studies which have been completed or are now underway in the various waterway segments.

CHAPTER SUMMARIES

Summaries of the five Main Report chapters follow. In order to make this overview a useful stand-along document, they include tables and figures that would otherwise be shown in the respective chapters.

Chapter 1. Physical System. The Inland Waterways Revenue Act of 1978 (Pub. L.95-502) and the Water Resources Development Act of 1986 (Pub. L.99-662) have been used to define the inland waterways system for the purposes of the Review. The 1978 Act imposed waterway fuel taxes on certain waterways that it explicitly described. The 1986 Act added one waterway to that system and prescribed cost-sharing of studies that differentiated that system from all other

Corps navigation projects. It also initiated use of the Inland Waterways Trust Fund created by the 1978 Act, for projects that were within or associated with that system. This system of waterway channels and locks is described in Chapter 1. It is summarized in Tables 1 and 2 at the end of this overview.

Chapter 1 includes an analysis of the commercial fleet of towboats and barges that operate on inland waterways, because it is the interaction of these vessels, the wharves and other waterfront facilities provided by non-Federal interests, and the waterway improvements built and maintained by the Corps, that determine how effectively they operate as a transportation system. It is noteworthy that the Inland Waterways Users Board has viewed the waterways as a transportation system in responding to its mandate to set priorities for system improvements. The interaction of vessel and lock operation is critical, particularly when queuing is involved. Improved communications have a potential for reducing traffic peaks to improve the efficiency of vessel and lock operation. The Corps has a fund of information on both, and the challenge is to apply it to systematic analysis in future reviews.

Appendix A gives details on the lock and channel system for each of the system segments.

Chapter 2. Inland Waterway Traffic: Historic Trends and Projections. The fuel-taxed inland waterway system accounts for about 90 percent of the "internal" traffic shown in the Corps Waterborne Commerce statistics. Internal traffic was a record 560.5 million short tons in 1986, a 4.8 percent increase over 1985. That percentage increase approximates the 4.2 percent average annual growth rate experienced in the period after World War II, up to 1979. Internal traffic plateaued in 1978-1980, declined in 1981-1983, and then increased, declined, and increased in 1984-1986. The average annual "growth" rate since 1978 has been about 0.6 percent. A number of factors were responsible for the traffic fluctuations in 1978-1986. Chapter 2 identifies these factors with analyses of the major commodity categories within the traffic total. The individual growth rates of major commodities are the basis for projections to the year 2000 for internal traffic and traffic on the nine waterway system segments. Figures 1 and 2 at the end of this overview summarize the historic trends and projections.

Chapter 2 gives projections for all internal traffic that show the differential growth rates of major commodity categories. The projections for the nine system segments are for total traffic only (all commodities). All projections are presented as a high-low range, the integrating device used to harmonize the national projections with segment-specific plans and studies. The projections for total internal traffic center on an annual growth rate of 1.5 percent. Most waterway segments have higher growth rates. The commodity projections include some negative as well as positive growth rates. Farm products are expected to have the greatest growth, centered on 3 percent per year. Crude petroleum would have the greatest decline, with a negative annual "growth" centered on 2 percent. The internal and segment-specific projections shown in Chapter 2 are in short tons. The combined total tons of the nine segments exceeds the inland total to the extent that some traffic moves on more than one segment. It is impractical to eliminate the double-counting when dealing with tons. Alternately, working with ton-miles would automatically eliminate double-counting, but the data bases used for commodity analysis and forecasting are not in that measure. It would be desirable to provide the Inland Waterways Users Board with projections in ton-miles, and to use ton-miles in projecting waterway fuel tax revenues. In general, growth of ton-miles parallels that of tons, but limited studies indicate differential growth in the average length of haul for specific commodities. This is another area for potential future study.

Very few of the sources of projections relevant to the inland waterways conclude with projections that are very far away from the overall mid-range. Grain traffic (primarily for export) is now projected to increase at a moderate rate (2 - 3 percent per year). Coal traffic for domestic power plants and for exports is projected to grow at about 2 percent per year. Several domestic nuclear plants are scheduled to begin operation in the next few years, which will suppress the growth rate in coal used for domestic utilities. However, one should not take the relatively smooth course generated in these projections too literally. There will undoubtedly be irregular movements up and down around the growth path. The current drought conditions have dropped water levels on the Mississippi River and result in light loading, smaller tows, delays from groundings and higher costs. The drought has resulted in sharply increased grain prices, and reduced sales to export customers. The drought, although a severe one is just one of the many regular perturbations which affect current and future waterways traffic. Projections tend to smooth irregularities since it is very difficult to model and to predict all the possible influences which affect waterway traffic. The principal thing to remember is that irregularities in the growth pattern are normal, not exceptional.

Appendix A gives traffic projections for the waterways in each system segment, and explains the procedures used to develop them.

<u>Chapter 3. Performance of Locks</u>. Traffic growth has little impact on the performance of projects which are far below capacity. But as traffic levels approach capacity, economic costs due to congestion-related delays increase exponentially. Chapter 3 has analyzed the relationship between delay time and lock utilization rates, and between delay time and stall or downtime frequency and duration. Based on the relationships for an "average" lock, a one percent increase in annual utilization produces 109 hours of delay or on the order of $76,000 of tow delay cost. Alternately, a one percent decrease as a result of less stall or downtime, produces savings on the same order. The analysis also shows that the frequency of stall events contributes more to delay time than does the duration of the stall. It is important to note that the analyses used an "average" lock, and effectively there is no such lock. A small percentage of the locks in the system produce most of the extreme values; most of the locks would be "below average".

The use of Performance Monitoring System data to produce the analyses requires several caveats. The chapter gives them with an explicit description of the performance indicators used in PMS and this review. Table 3.1 in Chapter 3 provides a list of all locks on the system, and shows key 1987 performance indicators where available. A ranking of locks based on these key indicators is useful in identifying "problem" locks. A number of rankings were produced, and they are shown in Tables 3 through 8. These tables are limited by page length to the top 40 projects in each ranking. Effectively, the "top 40" identifies all problem locks, and more-or-less the same population of projects appears in all tables. Footnotes show the projects that are the object of current improvement work or studies. Chapter 3 also includes a brief analysis of recreational use of selected locks. It is offered to illustrate a problem identified in a 1977 study by the Rock Island District. Recreational craft are most active during the summer, also a period of peak commercial tow traffic on the Upper Mississippi River. Recreational craft activity also peaks during weekends. Both commercial tows and recreational craft cause delays for each other when available lock capacity is highly utilized. Additional monitoring and study of this problem is indicated, along with identification and evaluation of alternatives.

<u>Chapter 4. Program Review</u>. It is customary to describe the Corps programs that improve and keep the waterways system functioning in terms of funding. That description obscures the

complexity of the task. The people struggling to do so in the field and in headquarters are real, albeit there are fewer each year. Their problems are diverse; because of the geographical spread of the system, some may be coping with droughts, while others have floods. Budget constraints are real. Since 1980, total expenditures on the inland waterways have been effectively flat in current dollars, at about $700 million, and declined in terms of constant dollars. The total masks disparate trends in operation and maintenance, and construction however. O&M has increased consistently, while construction declined almost as consistently, until it turned up in fiscal year 1988 as a result of P.L. 99-662 authorizations. Over the period, construction and O&M have held or more than held, respectively, their share of all Corps civil works funding. Construction began and ended the period at 26 percent, while O&M has increased from 28 to 31 percent.

Operations and maintenance costs for waterways subject to the fuel tax have increased by 81 percent in current prices and about 8 percent in real terms during the ten year period ending in 1986. During the same period, ton-mile traffic increased by 17 percent. The nominal cost per ton-mile increased from 1.0 mill in FY77 to 1.5 mills in FY86 but when costs are adjusted for inflation, there has been an 11 percent decrease in real costs per ton-mile. Major rehabilitation work initiated during the same period totals $463.3 million. The majority of that work has been completed, with $167.6 million of work underway but to be completed after FY88. Some of that rehabilitation work has been funded as construction, and the balance as O&M. There is now an ongoing effort by the Corps to revise major rehabilitation guidance. As part of this effort, a review of the potential work that could be categorized as rehabilitation for funding as construction has been performed. That review indicates that such potential work approximates $125 to $250 million. The inland waterways construction funding which declined to a low of $218 million in FY87, increased to $317 million in 1988, with allocations of $478 million in FY89. The total estimated cost of the improvement projects represented in construction funding is $12.7 billion. Seven billion of that total will require funding after FY89. The total estimated cost of projects authorized to be funded 50 percent from the Inland Waterways Trust fund is $2.976 billion, with $2.535 billion to be funded after FY89. The amounts are in current dollars. Amounts for unscheduled future work do not include inflation.

A prerequisite to the definitive assessment of future waterway system needs is comprehensive analysis using consistent assumptions as to traffic growth and system capacity. The Review is one of the means being used to improve consistency and uniformity. The planning program of the Ohio River Division is an example of comprehensive analysis of a regional system. ORD has studies underway of eight lock replacements and four additional locks. Their estimated construction cost (current dollars without inflation) is $2.295 billion. These improvements, if found economically justified, combined with the rehabilitation work and construction that is itemized in Chapter 4, will improve almost all of the "problem" locks identified by screening PMS data. (See Tables 2-7.) The analysis of the Inland Waterways Trust Fund indicates that the availability of funds will be a constraint on implementing all potential improvement projects. Accordingly, Chapter 4 describes a variety of relatively low cost improvements to increase capacity that were analyzed in the Upper Mississippi River Master Plan.

Table 9 shows the capacity estimates, and the percent of capacity used in 1987 for 40 locks that had high amounts of average delay and processing time, and total delay and stall time in PMS rankings. Projects above average in each performance indicator were assigned consecutive numbers representing their place in the queue, starting with the first project above average. Their consolidated ranking was determined by the sum of their place numbers.

Chapter 5 Status of the Inland Waterways Trust Fund. An analysis of the Inland Waterways Trust Fund shows that funding will be a substantial constraint on implementing more than 4 to 6 major improvement projects per decade, depending on cost growth. There will likely be $200 to $300 million per year, or $2 to 3 billion per decade, of construction and rehabilitation that can be funded, assuming a 50 percent share is drawn from the Trust Fund. The nine construction projects currently scheduled will cost almost $3 billion fully funded. They are scheduled to be completed by year 2001. The twelve projects under study in the Ohio River Division are estimated to cost $4.7 billion fully funded to reflect cost inflation out to estimated completion by 2009. This schedule cannot be funded by projected Trust Fund balances. The analysis shows that completion would be delayed 14 years if cost sharing is continued at 50 percent, and outlays are limited to Trust Fund revenues. In brief, it is likely that fewer construction projects can be started than can be economically justified.

The twelve projects under study in ORD have been used as a proxy for the additional improvements that are to be determined by a definitive needs assessment. As the division and system segment with the most locks, ORD studies address most of the system's problems. It is assumed that additional projects will be identified by other divisions, but the need for economic justification and screening for priorities on a system basis will produce a demand on the Trust Fund that is approximately the amount used. Chapter 5 explains the assumptions used to estimate tax revenues, interest earnings, inflation, and other variables. There are numerous alternate scenarios that can be analyzed. However, absent a fundamental change that would require Congressional action, such as change in fuel tax rate, Trust Fund cost share, or the need for Fund solvency, the annual or decade funding levels cited above apply. Table 10 shows the annual Trust Fund revenues, outlays, and balance for the scenario which extends construction duration in order to maintain fund solvency.

REVIEW SUMMARY AND CONCLUSIONS

Traffic on the inland waterways has begun slow but irregular growth after the declines from recession and decreased export shipments of coal and grain in early years of the 1980's. Average annual traffic growth is now projected to be on the order of 1 to 3 percent over the next decade at the national level, with somewhat higher growth rates on many of the fuel-taxed waterways. The waterway industry has finally reached a point where its equipment and people are achieving high utilization and improved returns on capital investment. The industry and the Corps have gone through cutbacks and tighter resources with good results. Both the public and private components of the waterway system are now leaner, meaner, and more cost effective.

Slower, but irregular, growth offers beneficial and adverse impacts on the decisions which have to be made concerning investments in new projects and more modern fleets, and in the resources devoted to operating and maintaining the navigation system (public and private). Slower growth, in the aggregate, buys some time to reach complex decisions regarding capital intensive investment; but erratic growth increases uncertainty in deciding the appropriate capital intensity of preferred investment alternatives and in deciding when to commit capital intensive outlays.

It is clear that the lock replacement projects now under construction will provide relief from delays in the currently most severely impacted segments. There are many other projects where the problem is expected to become significant in 10-20 years. These are the projects for which

alternatives, an economic analysis to determine feasibility, and/or analysis of optimal timing for implementation need to be available in time to fashion an intelligent investment policy. This report is a preliminary review of the needs, alternatives, and potential priorities. By necessity, it does not include enough detail (since many studies have not been started) to become a decision document for specific projects.

There is a need for regional waterway system plans to be brought up to a uniform level of detail promptly, to verify project traffic growth rates, and provide a basis for systematic demand -- capacity analysis.

There is a need to set priorities systematically. Priorities will inevitably be set in an environment of budget constraints. The challenge is to find a process which allows all reasonable claims for priority to be surfaced and a democratic discussion of the objectives which ultimately define the weights to be given various claims.

The Users Board has already begun to fashion a procedure by which they would assign priorities to studies, construction and operations/maintenance outlays. This procedure is based on 5 categories of urgency (or priority) since priority means little except what goes first. The User Board is emphasizing transportation benefits and high traffic density. Inevitably, tributary projects which contribute significant traffic to segments with high traffic density, will command additional priority. The priority must also be conditioned by the urgency of the problem(s) being addressed by individual projects within the overall system. Finally, the overall benefit-cost ratio and the composition of the benefits (transportation versus non transportation) should play a very important role.

Systematic priorities cannot be achieved without a systemwide investment planning process. The information developed at various stages of planning illuminate the choices and the problems. An ongoing investment planning process is being implemented by the Corps, starting with regional investment plans to be developed by the Corps divisions with inland navigation responsibilities during FY89. The Inland Waterway Review 1989 will summarize the findings and conclusions of the regional investment plans.

TABLE 1

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SEGMENT NUMBER 1 -- UPPER MISSISSIPPI

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
1	Upper St. Anthony Falls	853.9	1963	25	56	400	49
2	Lower St. Anthony Falls	853.3	1959	29	56	400	25
3	No. 1 Main Chamber	847.6	1930	58	56	400	38
	" Auxiliary Chamber	847.6	1932	56	56	400	38
4	No. 2 Main Chamber	815.0	1930	58	110	500	12
	" Auxiliary Chamber	815.0	1948	40	110	600	12
5	No. 3	769.9	1938	50	110	600	8
6	No. 4	752.8	1935	53	110	600	7
7	No. 5	738.1	1935	53	110	600	9
8	No. 5a	728.5	1936	52	110	600	5
9	No. 6	714.0	1936	52	110	600	6
10	No. 7	702.0	1937	51	110	600	8
11	No. 8	679.0	1937	51	110	600	11
12	No. 9	647.0	1938	50	110	600	9
13	No. 10	615.0	1936	52	110	600	8
14	No. 11	583.0	1937	51	110	600	11
15	No. 12	556.0	1938	50	110	600	9
16	No. 13	522.0	1938	50	110	600	11
17	No. 14 Main Chamber	493.9	1922	66	110	600	11
17	" Auxiliary Chamber	493.3	1939	49	80	320	11
18	No. 15 Main Chamber	482.9	1934	54	110	600	16
18	" Auxiliary Chamber	482.9	1934	54	110	360	16
19	No. 16	457.2	1937	51	110	600	9
20	No. 17	437.1	1939	49	110	600	8
21	No. 18	410.5	1937	51	110	600	10
22	No. 19	364.2	1957	31	110	1200	38
23	No. 20	343.2	1936	52	110	600	10
24	No. 21	324.9	1938	50	110	600	10
25	No. 22	301.2	1938	50	110	600	10
26	No. 24	273.4	1940	48	110	600	15
27	No. 25	241.4	1939	49	110	600	15
28	No. 26 Main Chamber	202.9	1938	50	110	600	24
28	" Auxiliary Chamber	202.9	1938	50	110	360	24
28	No. 26 Main (under const.)	200.8	1989	--	110	1200	24
28	" Aux. (under const.)	200.8	1992	--	110	600	24

SEGMENT NUMBER 2 -- MIDDLE MISSISSIPPI

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
1	L&D 27 Main chamber	185.1	1953	35	110	1200	21
1	" Auxiliary Chamber	185.1	1953	35	110	600	21
2	Kaskaskia	0.8	1973	15	84	600	32

SEGMENT NUMBER 3 -- LOWER MISSISSIPPI

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
	ARKANSAS RIVER						
1	Norrell	10.3	1967	21	110	600	30
2	Lock 2 & Mills Dam	13.3	1967	21	110	600	20
3	L&D 3	50.2	1968	20	110	600	20

TABLE 1 -- CONTINUED

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SEGMENT NUMBER 3 -- LOWER MISSISSIPPI -- CONTINUED

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
4	L&D 4	66.0	1968	20	110	600	14
5	L&D 5	86.3	1968	20	110	600	17
6	David T. Terry	108.1	1968	20	110	600	18
7	Murray	125.4	1969	19	110	600	18
8	Toad Suck	155.9	1969	19	110	600	16
9	Ormond	176.9	1969	19	110	600	20
10	Dardanelle	205.5	1969	19	110	600	55
11	Ozark	256.8	1969	19	110	600	34
12	James W. Trimble	292.8	1969	19	110	600	20
13	W.D. Mayo	319.6	1970	18	110	600	21
14	Robert S. Kerr	336.2	1970	18	110	600	48
15	Webbers Falls	366.6	1970	18	110	600	30
16	Chouteau (Verd. R)	401.5	1970	18	110	600	21
17	Newt Graham (Verd. R)	421.6	1970	18	110	600	21
	OUACHITA & BLACK RIVERS						
18	Jonesville	25.0	1972	16	84	600	30
19	Columbia	117.2	1972	16	84	600	18
20	Felsenthal	226.8	1984	4	84	600	18
21	Thatcher	281.7	1984	4	84	600	12
	RED RIVER						
22	L&D 1	43.0	1984	4	84	685	36
23	Overton	87.0	1987	1	84	685	24
	L&D 3 (under construction)	141.0	Indef	--	84	685	31
	ATCHAFALAYA (OLD) RIVER						
24	Old River	304.0	1963	25	75	1200	35

SEGMENT NUMBER 4 -- ILLINOIS WATERWAY

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
1	LaGrange L&D	80.2	1939	49	110	600	10
2	Peoria L&D	157.7	1939	49	110	600	11
3	Starved Rock L&D	231.0	1933	55	110	600	19
4	Marseilles L&D	244.6	1933	55	110	600	24
5	Dresden Island L&D	271.5	1933	55	110	600	22
6	Brandon Road L&D	286.0	1933	55	110	600	34
7	Lockport Lock	291.1	1933	55	110	600	40
8	T.J. O'Brien Lock	326.5	1960	28	110	1000	5

SEGMENT NUMBER 5 -- OHIO RIVER SYSTEM

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
	OHIO RIVER						
1	Emsworth	974.8	1921	67	110	600	18
	" Second Chamber		1921	67	56	360	18
2	Dashields	967.7	1929	59	110	600	10
	" Second Chamber		1929	59	56	360	10
3	Montgomery	949.3	1936	52	110	600	18
	" Second Chamber		1936	52	56	360	18

TABLE 1 -- CONTINUED

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SEGMENT NUMBER 5 -- OHIO RIVER SYSTEM -- CONTINUED

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER WIDTH (feet)	CHAMBER LENGTH (feet)	CHAMBER LIFT (feet)
4	New Cumberland	926.6	1959	29	110	1200	21
	" Second Chamber		1959	29	110	600	21
5	Pike Island	896.7	1968	20	110	1200	21
	" Second Chamber		1968	20	110	600	21
6	Hannibal	854.6	1972	16	110	1200	21
	" Second Chamber		1972	16	110	600	21
7	Willow Island	819.3	1972	16	110	1200	20
	" Second Chamber		1972	16	110	600	20
8	Belleville	777.1	1968	20	110	1200	22
	" Second Chamber		1968	20	110	600	22
9	Racine	743.5	1971	17	110	1200	22
	" Second Chamber		1971	17	110	600	22
10	Gallipolis	701.8	1937	51	110	600	23
	" Second Chamber		1937	51	110	360	23
10	Gallipolis (under const.)	701.8	1991	--	110	1200	23
	" Second Chamber		1991	--	110	600	23
11	Greenup	640.0	1959	29	110	1200	30
	" Second Chamber		1959	29	110	600	30
12	Meldahl	544.8	1962	26	110	1200	30
	" Second Chamber		1962	26	110	600	30
13	Markland	449.5	1963	25	110	1200	35
	" Second Chamber		1963	25	110	600	35
14	McAlpine First Chamber	374.2	1921	67	56	360	37
	" Second Chamber		1930	58	110	600	37
	" Third Chamber		1961	27	110	1200	37
15	Cannelton	260.3	1972	16	110	1200	25
	" Second Chamber		1972	16	110	600	25
16	Newburgh	204.9	1975	13	110	1200	16
	" Second Chamber		1975	13	110	600	16
17	Uniontown	135.0	1975	13	110	1200	18
	" Second Chamber		1975	13	110	600	18
18	Smithland	35.3	1980	8	110	1200	22
	" Second Chamber		1980	8	110	1200	22
19	L&D 52*	42.1	1969	19	110	1200	12
	" Second Chamber		1928	60	110	600	12
19	L&D 53*	18.4	1980	8	110	1200	12
	" Second Chamber		1929	59	110	600	12
19	Olmsted (Replaces 52 & 53)	----	----	--	110	1200	--
	" Second Chamber	----	----	--	110	1200	--
	MONONGAHELA RIVER						
20	L&D 2	11.2	1951	37	110	720	9
	" Second Chamber		1953	35	56	360	9
21	L&D 3	23.8	1907	61	56	720	8
	" Second Chamber		1907	81	56	360	8
22	L&D 4	41.5	1932	56	56	720	17
	" Second Chamber		1932	56	56	360	17
23	Maxwell	61.2	1964	24	84	720	20
	" Second Chamber		1964	24	84	720	20
24	Grays Landing (L&D 7)	85.0	1925	63	56	360	15
24	Grays Landing (under const.)	82.0	1993	--	84	720	15
25	Point Marion (L&D 8)	90.8	1925	63	56	360	19
25	Point Marion (under const.)	90.8	----	--	84	720	19
26	Morgantown	102.0	1950	38	84	600	17
27	Hildebrand	108.0	1959	29	84	600	21
28	Opekiska	115.4	1964	24	84	600	22
	ALLEGHENY RIVER						
29	L&D 2	6.7	1934	54	56	360	11
30	L&D 3	14.5	1934	54	56	360	14
31	L&D 4	24.2	1927	61	56	360	11
32	L&D 5	30.4	1927	61	56	360	12
33	L&D 6	36.3	1928	60	56	360	12
34	L&D 7	45.7	1930	58	56	360	13
35	L&D 8	52.6	1931	57		360	18
36	L&D 9	62.2	1938	50	56	360	22

* Temporary chambers

TABLE 1 -- CONTINUED

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SEGMENT NUMBER 5 -- OHIO RIVER SYSTEM -- CONTINUED

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER		
					WIDTH (feet)	LENGTH (feet)	LIFT (feet)
	KANAWHA RIVER						
37	Winfield	31.1	1937	51	56	360	28
37	" Second Chamber		1937	51	56	360	28
37	Winfield (under const.)	31.1	----	--	110	800	28
38	Marmet	67.8	1934	54	56	360	24
	" Second Chamber		1934	54	56	360	24
39	London	82.8	1934	54	56	360	24
	" Second Chamber		1934	54	56	360	24
	KENTUCKY RIVER						
40	L&D 1	4.0	1839	149	38	145	8
41	L&D 2	31.0	1839	149	38	145	14
42	L&D 3	42.0	1844	144	38	145	13
43	L&D 4	65.0	1844	144	38	145	13
	GREEN & BARREN RIVERS						
44	L&D 1	9.1	1956	32	84	600	12
45	L&D 2	63.1	1956	32	84	600	14
	CUMBERLAND RIVER						
46	Barkley	30.6	1964	24	110	800	57
47	Cheatham	148.7	1964	24	110	800	25
48	Old Hickory	216.2	1954	34	84	400	60
49	Cordell Hull	313.5	1973	15	84	400	59
	TENNESSEE & CLINCH RIVERS						
50	Kentucky	22.4	1944	44	110	600	56
51	Pickwick	206.7	1937	51	110	600	55
	" Second Chamber		1983	5	110	1000	55
52	Wilson	259.4	1927	61	60	300	94
	" Second Chamber		1927	61	60	292	--
	" Third Chamber		1959	29	110	600	94
53	Wheeler	274.9	1963	25	110	600	48
	" Second Chamber		1934	54	60	400	48
54	Guntersville	349.0	1965	23	110	600	39
	" Second Chamber		1937	51	60	360	39
55	Nickajack	424.7	1967	21	110	600	39
56	Chickamauga	471.0	1939	49	60	360	49
57	Watts Bar	529.9	1941	47	60	360	58
58	Ft. Loudon	602.3	1943	45	60	360	72

SEGMENT NUMBER 6 -- GULF INTRACOASTAL WATERWAY

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER		
					WIDTH (feet)	LENGTH (feet)	LIFT (feet)
	GULF INTRACOASTAL WATERWAY						
1	Inner Harbor	92.6	1923	65	75	640	17
2	Harvey Lock	98.2	1935	53	75	425	20
3	Algiers Lock	88.0	1956	32	75	760	18
4	Bayou Boeuf Lock	93.3	1954	34	75	1156	11
5	Leland Bowman Lock	162.7	1985	3	110	1200	5
6	Calcasieu Lock	238.5	1950	38	75	1206	4
7	Brazos River E. Fldgt	404.1	1954	34	75	----	--
7	Brazos River W. Fldgt	404.1	1954	34	75	----	--
8	Colorado River E. Lock	444.8	1954	34	75	1200	5
8	Colorado River W. Lock	444.8	1954	34	75	1200	5
	GIWW, MORGAN CITY TO PORT ALLEN ROUTE						
9	Port Allen	227.6	1961	27	84	1202	45
10	Bayou Sorrel	131.0	1952	36	56	747	21
	APALACHICOLA, CHATTAHOOCHEE, & FLINT RIVERS						
11	Jim Woodruff	106.3	1954	34	82	450	33
12	George W. Andrews	154.3	1962	26	82	450	25
13	Walter F. George	182.8	1963	25	82	450	88
	PEARL RIVER						
14	Lock 1	28.7	1951	37	65	310	17
15	Lock 2	40.8	1951	37	65	310	15
16	Lock 3	14.0	1951	37	65	310	11

TABLE 1 -- CONTINUED

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SEGMENT NUMBER 7 -- MOBILE RIVER AND TRIBUTARIES

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER		
					WIDTH (feet)	LENGTH (feet)	LIFT (feet)
	BLACK WARRIOR RIVER						
1	John Hollis Bankhead	365.7	1975	13	110	600	68
2	Holt	347.0	1966	22	110	600	64
3	Wm. Bacon Oliver	338.1	1939	49	95	460	28
3	* Replacement under const.	337.6	1991	--	110	600	28
4	Selden (Warrior)	261.7	1957	31	110	600	22
	TOMBIGBEE RIVER						
5	Demopolis	213.2	1954	34	110	600	40
6	Coffeeville	116.6	1960	28	110	600	34
	ALABAMA RIVER						
7	Claiborne	81.2	1969	19	84	600	30
8	Millers Ferry	142.3	1969	19	84	600	48
9	Robert F. Henry	245.4	1972	16	84	600	45
	TENNESSEE-TOMBIGBEE WATERWAY						
10	Gainesville	49.1	1978	10	110	600	36
11	Aliceville	89.8	1979	9	110	600	27
12	Columbus	117.6	1980	8	110	600	27
13	Aberdeen	140.0	1985	3	110	600	27
14	A	154.0	1985	3	110	600	30
15	B	159.3	1985	3	110	600	25
16	C	174.0	1985	3	110	600	25
17	D	181.0	1985	3	110	600	30
18	E	189.0	1985	3	110	600	30
19	Bay Springs	194.9	1985	3	110	600	84

SEGMENT NUMBER 8 -- ATLANTIC INTRACOASTAL WATERWAY

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER		
					WIDTH (feet)	LENGTH (feet)	LIFT (feet)
	ALBEMARLE & CHESAPEAKE CANAL ROUTE						
1	Great Bridge	11.5	1932	56	75	600	3
	DISMAL SWAMP CANAL ROUTE						
2	South Mills	33.2	1941	47	52	300	12
3	Deep Creek	10.6	1940	48	52	300	12

SEGMENT NUMBER 9 -- COLUMBIA-SNAKE-WILLAMETTE

	LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBER		
					WIDTH (feet)	LENGTH (feet)	LIFT (feet)
	COLUMBIA & SNAKE RIVERS						
1	Bonneville	146.0	1938	50	76	500	65
	Bonneville (under const.)	146.0	1992	--	86	675	65
2	The Dalles	190.0	1957	31	86	675	88
3	John Day	215.0	1968	20	86	675	110
4	McNary	282.0	1953	35	86	675	75
5	Ice Harbor	9.7	1962	26	86	675	100
6	Lower Monumental	41.6	1969	19	86	675	98
7	Little Goose	70.3	1970	18	86	675	98
8	Lower Granite	107.5	1975	13	86	675	100
	WILLAMETTE RIVER						
9	Willamette Falls Locks	26.4	1873	115	40	210	(5chs)20

TABLE 1 -- CONTINUED

INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS

SUMMARY DATA

SEGMENT NUMBER AND NAME	LOCK PROJECTS	LOCK CHAMBERS	PROJECTS UNDER CONSTRUCTION WITH FUEL TAX FUNDING	PROJECTS UNDERGOING P.E.& D.
1 -- UPPER MISSISSIPPI	28	33	1	0
2 -- MIDDLE MISSISSIPPI	2	3	0	0
3 -- LOWER MISSISSIPPI	24	24	0	0
4 -- ILLINOIS WATERWAY	8	8	0	0
5 -- OHIO RIVER SYSTEM	58	95	4	1
6 -- GULF INTRACOASTAL WATERWAY	16	18	0	0
7 -- MOBILE RIVER AND TRIBUTARIES	19	19	1	0
8 -- ATLANTIC INTRACOASTAL WATERWAY	3	3	0	0
9 -- COLUMBIA-SNAKE-WILLAMETTE	9	13	1	0
TOTAL	167	216	7	1

P. E. & D. = Preconstruction Engineering and Design

NAMES OF PROJECTS DENOTED IN LAST TWO COLUMNS OF SUMMARY DATA

SEGMENT NUMBER AND NAME	PROJECTS UNDER CONSTRUCTION WITH FUEL TAX FUNDING	PROJECTS UNDERGOING P.E.& D.
1 -- UPPER MISSISSIPPI	L&D NO. 26	(No Projects)
5 -- OHIO RIVER SYSTEM	GALLIPOLIS GRAYS LANDING POINT MARION WINFIELD	OLMSTED
7 -- MOBILE RIVER & TRIBUTARIES	OLIVER	(No Projects)
9 -- COLUMBIA-SNAKE-WILLAMETTE	BONNEVILLE	(No Projects)

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

TABLE 2
FUEL TAX WATERWAY SEGMENTS
LENGTHS

Segment/Waterway	Length (miles)
1. UPPER MISSISSIPPI	
Mississippi, Mpls, MN to Mo. R.	663
2. MIDDLE MISSISSIPPI	
Mississippi, Mo. R. to Ohio R.	195
Kaskaskia River	36
Missouri River, Sioux City to Mouth	735
3. LOWER MISSISSIPPI	
Mississippi River, Ohio R. to Baton Rouge, LA.	720
McClellan-Kerr Arkansas River	448
White River to Newport, AR	255[2]
Ouachita - Black Rivers	351
Red River to Shreveport, LA	236[2]
Atchafalaya River and Old River	220
4. ILLINOIS WATERWAY	357
5. OHIO RIVER SYSTEM	
Ohio River	981
Monongahela River	129
Allegheny River	72
Kanawha River	91
Kentucky River	82[2]
Green River[4]	149
Cumberland River	387
Tennessee and Clinch Rivers	652
6. GULF INTRACOASTAL WATERWAY	
GIWW: St. Marks, FL to N.O., LA	437
GIWW: N.O. to Brownsville, TX	690
GIWW: Morgan City-Port Allen	65
Apalachicola, Chattahoochee and Flint	297
Pearl River	58[2]
7. MOBILE RIVER AND TRIBUTARIES	
Mobile, Black Warrior, and Tombigbee Rivers	453
Tennessee-Tombigbee	234
Alabama River	305

TABLE 2 (Continued)
FUEL TAX WATERWAY SEGMENTS
LENGTHS

Segment/Waterway	Length (miles)
8. ATLANTIC INTRACOASTAL WATERWAY	
AIWW: Norfolk-Jacksonville, FL (2 routes)	793
IWW: Jacksonville to Miami, FL	370
9. COLUMBIA-SNAKE WATERWAY	
Columbia R.: The Dalles to Richland, WA	135[1]
Snake R. to Lewiston, ID	230
Willamette River to Corvallis, OR	118[2]
Total U.S. Fuel Tax Segments	10,944
Segments not suject to fuel tax	
Minnesota, St. Croix and Black R.	52
Okeechobee Waterway	154
Cape Fear River	111
New York State Waterways	522
Total	11,783

NOTE: [1] Deep Draft Segment is not subject to fuel tax.
[2] Depths less than 9 feet.
[3] Chambers built before 1940.
[4] 149 miles are taxed; however, navigation is possible for only 103 miles. Lock # 3 in no longer operable.

TABLE 3

PERFORMANCE MONITORING SYSTEM

LOCKS WITH HIGH AVERAGE DELAY IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

AVGE DELAY RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
No. 17 (Upper Miss)	334	420	15981	62	17	58	29.2
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
No. 22 (Upper Miss) (2)	204	300	11132	105	28	64	34.2
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
Chickamauga (Tenn) (3)	106	419	1365	65	29	52	3.3
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
No. 13 (Upper Miss)	79	138	3491	49	14	45	19.4
No. 14 (Upper Miss) (2)	78	146	3969	79	35	60	24.4
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
PMS AVERAGE DELAY AVGE	73.07						
Bonneville(Columbia) (1)	69	165	2373	18	16	53	8.9
Calcasieu Lock(GIWW)	68	95	15661	265	291	72	N.A.
Bayou Sorrel (GIWW)	62	90	5315	213	65	41	22.0
No. 12 (Upper Miss)	60	123	2519	19	39	46	19.3
Kaskaskia	58	83	289	1558	6	11	3.1
Harvey Lock (GIWW)	57	91	4012	137	285	47	3.5
Cannelton (Ohio)	56	113	4914	59	54	32	61.0
Brandon Road (Ill) (2)	56	121	3250	123	114	48	14.4
Ft. Loudon (Tenn) (3)	52	188	245	163	49	17	0.6
Leland Bowman (GIWW)	51	74	12111	5	16	64	42.2
No. 11 (Upper Miss)	49	122	1516	30	5	49	15.8
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 4

PERFORMANCE MONITORING SYSTEM

LOCKS WITH HIGH AVERAGE PROCESSING TIME IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

AV PROCESS TIME RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
No. 17 (Upper Miss)	334	420	15981	62	17	58	29.2
Chickamauga (Tenn) (3)	106	419	1365	65	29	52	3.3
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
Watts Bar (Tenn) (3)	42	332	275	27	42	29	1.9
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
No. 22 (Upper Miss) (2)	204	300	11132	105	28	64	34.2
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
Ft. Loudon (Tenn) (3)	52	188	245	163	49	17	0.6
Marmet (Kanawha) (3)	35	183	3300	96	18	48	10.1
Bonneville(Columbia) (1)	69	165	2373	18	16	53	8.9
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
No. 14 (Upper Miss) (2)	78	146	3969	79	35	60	24.4
London (Kanawha)	39	140	2267	1039	344	21	3.9
No. 13 (Upper Miss)	79	138	3491	49	14	45	19.4
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
PMS AV PROCESS AVERAGE		134.24					
No. 12 (Upper Miss)	60	123	2519	19	39	46	19.3
No. 11 (Upper Miss)	49	122	1516	30	5	49	15.8
Wheeler (Tenn)	20	121	354	34	20	22	7.4
Brandon Road (Ill) (2)	56	121	3250	123	114	48	14.4
Wilson (Tenn)	27	120	645	46	23	37	7.7
Cannelton (Ohio)	56	113	4914	59	54	32	61.0
Dresden Island (Ill) (2)	44	112	2170	39	35	46	16.7

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 5

PERFORMANCE MONITORING SYSTEM

LOCKS WITH HIGH TOTAL DELAY TIME IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

TOTAL DELAY RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
No. 17 (Upper Miss)	334	420	15981	62	17	58	29.2
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
Calcasieu Lock (GIWW)	68	95	15661	265	291	72	N.A.
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
Leland Bowman (GIWW)	51	74	12111	5	16	64	42.2
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
No. 22 (Upper Miss) (2)	204	300	11132	105	28	64	34.2
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
PMS TOTAL DELAY AVERAGE			5636.70				
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
Bayou Sorrel (GIWW)	62	90	5315	213	65	41	22.0
Cannelton (Ohio)	56	113	4914	59	54	32	61.0
Harvey Lock (GIWW)	57	91	4012	137	285	47	3.5
No. 14 (Upper Miss) (2)	78	146	3969	79	35	60	24.4
Bayou Boeuf (GIWW)	16	41	3841	170	60	56	27.2
Willow Island (Ohio)	10	60	3540	65	6	0	28.7
Uniontown (Ohio)	31	76	3528	178	52	34	77.6
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
No. 13 (Upper Miss)	79	138	3491	49	14	45	19.4
L&D 7 (Mon) (1)	39	92	3317	48	17	59	14.3
Marmet (Kanawha) (3)	35	183	3300	96	18	48	10.1
Brandon Road (Ill) (2)	56	121	3250	123	114	48	14.4
Newburgh (Ohio)	24	71	2740	59	230	36	69.7

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 6

PERFORMANCE MONITORING SYSTEM

LOCKS WITH HIGH TOTAL DOWNTIME IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

STALL TIME RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
Kaskaskia	58	83	289	1558	6	11	3.1
Maxwell (Mon)	2	37	249	1301	9	53	16.3
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
London (Kanawha)	39	140	2267	1039	344	21	3.9
Racine (Ohio)	18	71	1631	1008	41	17	31.6
L&D 2 (Mon) (3)	15	59	1065	981	12	53	17.7
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
Hannibal (Ohio)	12	65	605	769	57	33	N.A.
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
Markland (Ohio)	32	87	2509	552	50	21	53.9
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
Ice Harbor (Snake)	11	47	253	374	80	17	3.8
McNary (Columbia)	6	42	151	347	35	13	6.5
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
Smithland (Ohio)	6	55	791	328	137	37	87.2
PMS STALL TIME AVERAGE				323.67			
Lwr Monumentl (Snake)	8	49	134	305	14	11	3.2
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
Calcasieu Lock (GIWW)	68	95	15661	265	291	72	N.A.
Lower Granite (Snake)	4	34	59	263	7	10	2.2
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Little Goose (Snake)	5	36	76	243	4	8	3.1
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
Pike Island (Ohio)	11	61	621	221	11	44	34.0
Bayou Sorrel (GIWW)	62	90	5315	213	65	41	22.0
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
Old River (Atchaflya)	27	63	1349	179	53	28	8.0
Uniontown (Ohio)	31	76	3528	178	52	34	77.6
Bayou Boeuf (GIWW)	16	41	3841	170	60	56	27.2
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
Ft. Loudon (Tenn) (3)	52	188	245	163	49	17	0.6
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 7

PERFORMANCE MONITORING SYSTEM

LOCKS WITH HIGH NUMBER OF STALLS IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

STALL NUMBER RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
London (Kanawha)	39	140	2267	1039	344	21	3.9
Calcasieu Lock(GIWW)	68	95	15661	265	291	72	N.A.
Harvey Lock (GIWW)	57	91	4012	137	285	47	3.5
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
Newburgh (Ohio)	24	71	2740	59	230	36	69.7
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
Smithland (Ohio)	6	55	791	328	137	37	87.2
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
Brandon Road (Ill) (2)	56	121	3250	123	114	48	14.4
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0
Ice Harbor (Snake)	11	47	253	374	80	17	3.8
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
No. 19 (Upper Miss) (2)	45	107	2226	146	72	43	31.2
PMS STALL EVENTS AVGE					70.79		
Bayou Sorrel (GIWW)	62	90	5315	213	65	41	22.0
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
Bayou Boeuf (GIWW)	16	41	3841	170	60	56	27.2
Starved Rock (Ill) (2)	44	111	2116	31	58	45	19.3
Hannibal (Ohio)	12	65	605	769	57	33	N.A.
Cannelton (Ohio)	56	113	4914	59	54	32	61.0
Old River(Atchaflya)	27	63	1349	179	53	28	8.0
Uniontown (Ohio)	31	76	3528	178	52	34	77.6
Markland (Ohio)	32	87	2509	552	50	21	53.9
Ft. Loudon (Tenn) (3)	52	188	245	163	49	17	0.6
Cheatham(Cumberland)	11	62	213	73	46	12	4.9

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 8

PERFORMANCE MONITORING SYSTEM

LOCKS WITH ABOVE AVERAGE UTILIZATION IN 1987

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

UTILIZATION RANK LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
Calcasieu Lock(GIWW)	68	95	15661	265	291	72	N.A.
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
No. 22 (Upper Miss) (2)	204	300	11132	105	28	64	34.2
Leland Bowman (GIWW)	51	74	12111	5	16	64	42.2
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
Emsworth (Ohio) (2)(3)	25	80	1730	118	14	63	20.4
No. 1 (Upper Miss) (2)	2	35	49	3	2	62	1.3
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
No. 14 (Upper Miss) (2)	78	146	3969	79	35	60	24.4
L&D 7 (Mon) (1)	39	92	3317	48	17	59	14.3
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
L&D 3 (Mon) (2)(3)	16	50	1675	51	3	59	19.9
No. 17 (Upper Miss)	334	420	15981	62	17	58	29.2
Dashields (Ohio) (2)(3)	30	91	1965	74	20	57	21.7
Bayou Boeuf (GIWW)	16	41	3841	170	60	56	27.2
L&D 4 (Mon) (3)	22	69	1720	55	7	55	17.7
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
Maxwell (Mon)	2	37	249	1301	9	53	16.3
L&D 2 (Mon) (3)	15	59	1065	981	12	53	17.7
Bonneville(Columbia) (1)	69	165	2373	18	16	53	8.9
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
Chickamauga (Tenn) (3)	106	419	1365	65	29	52	3.3
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
New Cumberland(Ohio)	12	68	634	31	9	50	28.2
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
No. 11 (Upper Miss)	49	122	1516	30	5	49	15.8
Marmet (Kanawha) (3)	35	183	3300	96	18	48	10.1
L&D 8 (Mon) (1)	21	69	1553	60	4	48	12.2
PMS UTILIZATION AVGE						39.03	

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 9

CAPACITY UTILIZATION

LOCKS WITH HIGH DELAYS & DOWNTIME

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

TOP 40 LOCK NAME & (RIVER)	ESTIMATED LOCK CAP. MILL.TONS LOW	HIGH	LOCK TRAFFIC MILLIONS OF TONS	PERCENT CAPACITY USED LOW	HIGH	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	PMS RANK EQUAL BASIS
Inner Harbor (GIWW) (1)	31	35	26.3	87.7	75.1	548	592	106551	1616	103
L&D 26 (Upper Miss) (1)	70	75	69.3	99.0	92.4	465	552	56165	377	86
No. 20 (Upper Miss) (2)	53	57	31.9	60.2	56.0	867	961	46030	244	84
Gallipolis (Ohio) (1)	45	55	34.5	76.7	62.7	291	392	20608	1141	83
No. 17 (Upper Miss)	53	54	29.2	55.1	54.1	334	420	15981	62	73
Winfield (Kanawha) (1)	18	22	17.3	96.1	78.6	244	416	13066	785	70
McAlpine (Ohio) (3)	82	116	55.9	68.2	48.2	296	356	26186	287	69
Meldahl (Ohio)	97	133	46.3	47.7	34.8	200	269	14387	3235	68
L&D 52 (Ohio) (1)(2)	100	115	N.A.	N.A.	N.A.	169	216	27523	1834	68
LaGrange (Ill) (2)	46	49	30.3	65.9	61.8	295	371	15384	230	64
Kentucky (Tenn) (3)	35	39	30.1	86.0	77.2	247	356	15786	194	62
No. 24 (Upper Miss)	59	60	35.3	59.8	58.8	246	335	13328	62	56
Algiers Lock (GIWW)	26	29	26.7	102.7	92.1	217	262	36565	165	56
No. 25 (Upper Miss)	59	60	35.3	59.8	58.8	231	315	12285	141	50
No. 16 (Upper Miss	48	49	27.2	56.7	55.5	216	294	11256	158	44
Pickwick (Tenn)	75	80	17.8	23.7	22.3	130	231	5448	1255	43
No. 22 (Upper Miss) (2)	44	52	34.2	77.8	65.8	204	300	11132	105	43
No. 21 (Upper Miss) (2)	52	57	33.4	64.2	58.6	135	218	7264	692	40
Montgomery (Ohio) (2)(3)	37	39	23.0	62.2	59.0	104	157	7383	6652	39
Chickamauga (Tenn) (3)	5	7	3.3	66.0	47.1	106	419	1365	65	35
No. 15 (Upper Miss)	49	50	25.2	51.4	50.4	121	188	8288	389	30
Lockport (Ill) (2)	33	33	13.9	42.1	42.1	127	198	7259	336	28
No. 18 (Upper Miss)	55	56	29.8	54.2	53.2	111	193	5385	513	26
Port Allen (GIWW)	32	35	19.2	60.0	54.9	77	136	6688	2402	25
Watts Bar (Tenn) (3)	5	7	1.9	38.0	27.1	42	332	275	27	22
Peoria (Ill) (2)	44	52	26.4	60.0	50.8	125	188	6947	155	22
Kaskaskia	30	35	3.1	10.3	8.9	58	83	289	1558	18
Maxwell (Mon)	59	95	16.3	27.6	17.2	2	37	249	1301	17
London (Kanawha)	18	22	3.9	21.7	17.7	39	140	2267	1039	17
Calcasieu Lock(GIWW)	N.A.	60	N.A.	N.A.	70.3	68	95	15661	265	16
Racine (Ohio)	107	138	31.6	29.5	22.9	18	71	1631	1008	13
L&D 2 (Mon) (3)	50	74	17.7	35.4	23.9	15	59	1065	981	12
Leland Bowman (GIWW)	N.A.	N.A.	42.2	N.A.	N.A.	51	74	12111	5	10
Hannibal (Ohio)	110	132	N.A.	N.A.	N.A.	12	65	605	769	10
Ft. Loudon (Tenn) (3)	5	7	0.6	12.0	8.6	52	188	245	163	9
Marmet (Kanawha) (3)	18	22	10.1	56.1	45.9	35	183	3300	96	8
Markland (Ohio)	89	133	53.9	60.6	40.5	32	87	2509	552	8
No. 14 (Upper Miss) (2)	51	52	24.4	47.8	46.9	78	146	3969	79	7
L&D 27 (Upper Miss)	142	158	78.0	46.2	41.7	49	88	9125	246	7
Bonneville(Columbia) (1)	12	12	8.9	74.2	74.2	69	165	2373	18	7

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 10

INLAND WATERWAYS TRUST FUND

ANALYSIS OF ESTIMATED INCOME AND OUTLAYS

(SCENARIO BASED ON NUMBER OF PROJECTS THAT MAY BE FOUND JUSTIFIED, CONSTRUCTION TIMING DETERMINED BY AVAILABLE FUND BALANCES, ULTIMATE COST DETERMINED BY TIMING OF CONSTRUCTION AND INTEREST/INFLATION ASSUMPTIONS)

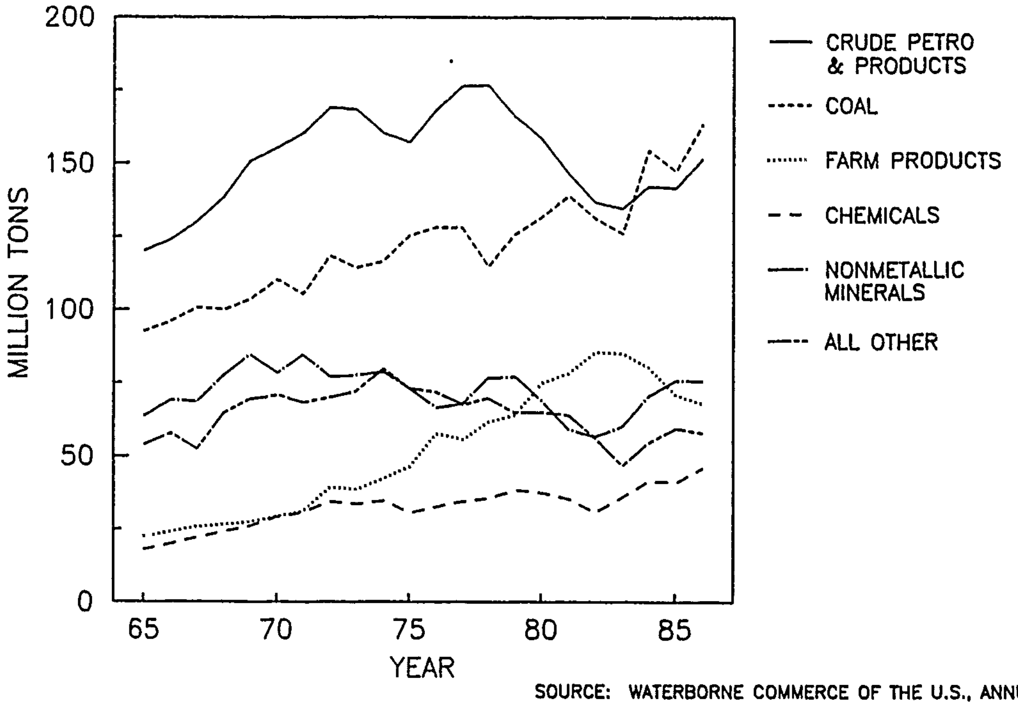
Year	Estimated Outlays	Tax Revenues	Interest Earnings	Year-End Balance
1987	33658000	48000000	0	279,000,000
1988	66245000	48720000	22320000	283,795,000
1989	87371000	49450800	23838780	269,713,580
1990	129600000	55211818	23195368	218,520,766
1991	116750000	66229086	18792786	186,792,638
1992	96399000	77564448	16250959	184,209,045
1993	114645000	89224970	16210396	174,999,412
1994	113088000	101217856	15224949	178,354,216
1995	169599229	108143288	15338463	132,236,739
1996	159494229	109765438	11372360	93,880,307
1997	155739229	111411919	8073706	57,626,704
1998	150739229	113083098	4840643	24,811,216
1999	140739229	114779344	2059331	910,663
2000	106138229	116501035	75585	11,349,054
2001	73674076	118248550	930622	56,854,150
2002	65704076	120022278	4662040	115,834,393
2003	153428827	121822613	9498420	93,726,598
2004	153428827	123649952	7685581	71,633,304
2005	153428827	125504701	5873931	49,583,109
2006	167859792	127387272	4065815	13,176,403
2007	121685716	129298081	1080465	21,869,233
2008	121685716	131237552	1793277	33,214,346
2009	119184569	133206115	2723576	49,959,469
2010	119184569	135204207	4096676	70,075,783
2011	119184569	137232270	5746214	93,869,697
2012	104753604	139290754	7697315	136,104,162
2013	104753604	141380115	11160541	183,891,214
2014	225555462	143500817	15079080	116,915,649
2015	120801857	145653329	9587083	151,354,204
2016	188029601	147838129	12411045	123,573,778
2017	188029601	150055701	10133050	95,732,928
2018	188029601	152306537	7850100	67,859,964
2019	223816459	154591135	5564517	4,199,157
2020	103014601	156910002	344331	58,438,888

Note: Anticipated projects include nine authorized to draw from the Trust Fund and 12 additional projects under study.

FIGURE 1

U.S. INLAND WATERWAY TRAFFIC BY COMMODITY

1965–1986

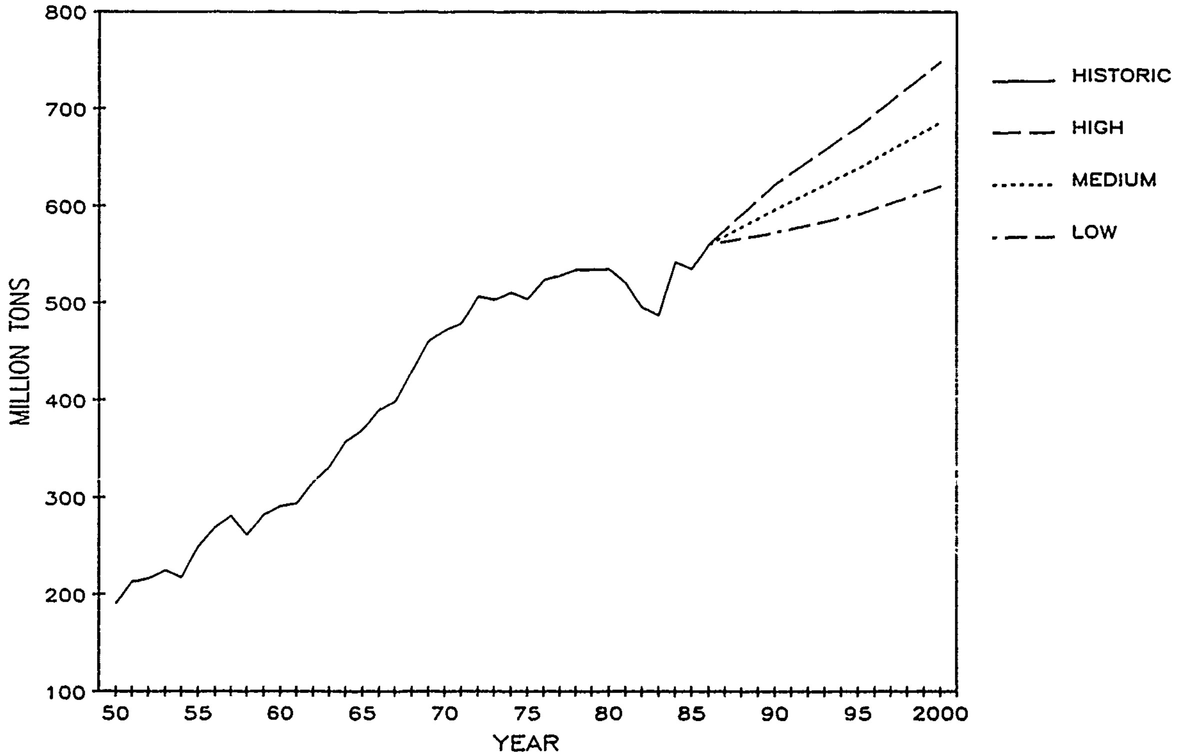


SOURCE: WATERBORNE COMMERCE OF THE U.S., ANNUAL.

FIGURE 2

U.S. TOTAL INTERNAL WATERBORNE COMMERCE

HISTORIC 1950–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

Chapter 1

PHYSICAL SYSTEM

CHANNELS AND LOCKS

More than a half billion tons of commodities are transported through the 216 lock chambers at 167 lock sites on the 11,000 miles of fuel taxed segments on the nation's shallow draft inland and intracoastal waterway system. Most of the channels in the system are shallow draft with depths of 9 to 14 feet. Figure 1.1 shows the system. A larger map which shows the principal segments is shown on page A-3 in Appendix A. Table 1 describes the principal waterways.

Operators of commercial vessels on fuel tax segments are subject to the federal inland waterways fuel tax. For summarization purposes, the 27 waterways have been aggregated into nine major segments shown in Figure 1.2 and Table 1. The fuel tax, authorized by Public Law 95-502 (Inland Waterways Revenue Act of 1978) and Public Law 99-662 (Water Resources Development Act of 1986), is currently $.10 per gallon of fuel used by commercial vessels on the 27 designated waterways, but will increase to $.20 per gallon by 1995.

The physical characteristics described in this chapter and the appendix include channel length (Figure 1.3), width, and depth; chamber length, width, and lift; age of lock, and existence of auxiliary locks (Table 1).

Channels

The generally north-south oriented Mississippi River and its tributaries are the nation's major inland river transportation network and include the Mississippi, Ohio, Illinois, Arkansas, Tennessee, Missouri and other navigable rivers. These improved navigable channels contain 85 percent of the network's navigable channels with controlling depths of at least 9 feet.

The dominantly east-west oriented Gulf Intracoastal Waterway (GIWW) extends along the coast of the Gulf of Mexico for about 1,100 miles, from St. Marks, Florida, to Brownsville, Texas, on the border with Mexico. Nearly midway along the coast the Mississippi River intersects the GIWW at New Orleans. East of New Orleans the GIWW is intersected by a number of rivers, streams, and channels, including the Mobile River and its tributaries and the Apalachicola-Chattahoochee-Flint System. To the west, waterway traffic enters the GIWW from many intersecting waterways, including the GIWW--Morgan City to Port Allen Route, the Atchafalaya River, and the deep draft Houston Ship Channel.

The Mississippi River and its tributaries and the GIWW connect Gulf Coast ports -- such as New Orleans, Houston, Baton Rouge, Beaumont, Corpus Christi, and Mobile -- with major inland ports -- St. Louis, Pittsburgh, Huntington, Cincinnati, Memphis, and Chicago. This major network also provides the operational setting for about 3,200 towboats and 28,000 barges.

Concomitantly, the controlling depth of 45 feet in the section of the Mississippi River from Baton Rouge to the Gulf of Mexico allows ocean shipping to join the barge traffic, thereby making this segment vital to both the domestic and foreign trade of the United States.

The Atlantic Intracoastal Waterway is a combination of protected coastal waterways and connecting canal segments which run parallel to the Atlantic Coast between Norfolk, Virginia, and Jacksonville, Florida. Another section known as the Intracoastal Waterway continues from

Jacksonville southward to the Florida Keys. A partially protected stretch of the Atlantic Intracoastal Waterway also extends along the Atlantic side of the Delmarva Peninsula and along the coasts of New Jersey and Long Island, NY. Atlantic Coast ports and deep draft channels are connected with areas further inland by other shallow draft waterways that are not very long and serve only a limited area.

The shallow-draft inland and coastal waterways of the Pacific Coast include the Columbia-Snake Waterway and the Willamette River above Portland, Oregon; the Sacramento River above Sacramento, California; the San Joaquin River above Stockton, California; and a few short navigable river stretches along the Washington and Oregon coasts. As on the Atlantic Coast, deep draft channels carry most of the waterborne commerce. These channels include the Columbia River below Portland; Puget Sound; the Sacramento and Stockton Deep Draft Ship Channels; and San Francisco Bay.

Locks

There are 167 commercially active locks with 216 chambers in the nine segments. The locks are generally of three lengths. Twelve percent of the lock chambers are 1,000 to 1,200 feet long, fifty-four percent are 600-999 feet long, and thirty-four percent are less than 600 feet long. Widths are mostly 110 feet. Medium and small sized locks are main and auxilliary chambers on the main rivers or single locks on the smaller tributary rivers. The 110 foot wide by 600 or 1200 foot long locks can accommodate a tow made up of 8 to 17 jumbo barges each measuring 35 feet wide by 195 feet long and designed to operate in a 9-foot channel. The lock size and barge size are critical factors in the amount of cargo that can pass through a lock in a given period of time, as will be discussed below.

The ages of the operating chambers of the major locks on the nine waterway segments are summarized in Table 1.1 and Figure 1.4. The locks range in age from less than a year old on the Red River to 151 years old on the Green River. About one-third of the chambers are 20 years old or less, and over two-fifths of the chambers will be more than 50 years old by the end of this decade. The median age of all chambers is almost 35 years.

Despite the range in age and the number of relatively new lock chambers, there are significant signs of age within the system. Locks on any given waterway tend to be from the same era. Problems that come with aging locks on the waterways tend to affect many locks at the same time.

All but five chambers on the Upper Mississippi were built before 1940. On the Illinois Waterway, all but one lock will be over 50 years old by the end of the decade. Every lock on the Kanawha River is 50 or more years old. The Allegheny River's youngest lock is 49 years old. Locks with ages of 50 or more years can be found on the Monongahela, Green, Tennessee/Clinch and Ohio Rivers. The three Atlantic Intracoastal Waterway locks are nearly 50 years old. The Willamette River in the Columbia-Snake Waterway segment has five locks, each of which is over 100 years old, and one Columbia River lock is 50 years old.

At the other end of the age distribution is the Tennessee-Tombigbee Waterway, placed in operation in 1985. The entire Mobile River and Tributaries Waterway is relatively new, with only three locks over 30 years old. The Gulf Intracoastal Waterway is a middle-aged system fitting neither the new nor old cohorts described above. Most of its locks range from 24 to 37 years old. For additional data regarding locks see the Annual Report FY86 of the Secretary of the Army Civil Works Activities, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

COMMERCIAL FLEET

This section describes the characteristics, operations and utilization of the existing fleet of vessels serving the inland waterways. Three vessel types are considered - dry cargo barges, liquid cargo barges, towboats/tugboats.

Dry Cargo Barges

In 1985 there were about 29,300 dry cargo barges with a total cargo capacity of over 38 million tons or 1,320 tons per barge (Table 1.2). Since 1950 the number of barges, shown in Figure 1,5, has grown 160 percent from just over 11,300 to its present size. The fleet's cargo capacity has increased from less than 8 million tons, an increase of 320 percent. Consequently, the average capacity per barge nearly doubled from 700 tons over the past 35 years. The dry cargo barge fleet is predominantly open hopper, covered hopper, and deck or flat barges. They are employed on the shallow-draft waterways as well as in deep-draft areas along the coasts and on the Great Lakes.

In the Mississippi River and Tributaries - GIWW region in 1985 there were over 24,000 cargo barges with a total cargo capacity of almost 33 million tons. This region propelled the U.S. fleet's growth.

Operating in the Mississippi River and tributaries - GIWW region are about 50 different types and sizes of barges. Dry cargo barges comprise 88 percent of the barges and 82 percent of cargo capacity in the region; they average 15 years in age (Table 1,3). The 195 foot length predominates, comprising 75 percent of the barges and 85 percent of the cargo capacity. Jumbo barges are 35 feet wide while standard barges are 26 feet wide and shorter. Covered hopper barges account for about half and open hopper barges for over one quarter of the region's dry cargo barge capacity.

Tank Barges

The tank barge fleet in 1985 was about 4,250 barges with a total cargo capacity exceeding 10.8 million tons (Table 1,4). Since 1950 the number of barges, as shown in Figure 1.6, has more than doubled. However, the fleet's cargo capacity has increased at triple that rate (310 percent) from just over 2.6 million tons. Tank barges are employed in the same regions of the country as are dry cargo barges.

In the Mississippi River and Tributaries - GIWW region in 1985 as shown in Table 1.5 there were over 3,500 tank barges with a total cargo capacity of over 7.3 million tons. The three most common barge lengths are, in order of importance, 250 - 300, 190 - 200, and less than 170 foot lengths. There is also greater diversity in barge widths. Compartmented barges account for 40 percent of the barges (1,350) and total capacity (2.8 million tons) and average 19 years old. Non-compartmented barges account for 60 percent of the barges (2,050) and total capacity (4.2 million tons) and average one year younger. With high capital and operating costs for tank and dry cargo barges plus towboats under normal operations, the impact of added transportation costs caused by congestion and delay at locks becomes very apparent.

Towboats and Tugboats

In 1985 there were approximately 5,000 towboats and tugboats in the United States fleet (Table 1.6). Together, the fleet totaled over 8 million horsepower or 1,600 horsepower per

vessel. The fleet size has grown 20 percent in 35 years from less than 4,100 boats (Figure 1.7). However, its total horsepower has increased 365 percent from about 1.7 million in 1950.

In the Mississippi River - GIWW region there were over 3,200 towboats and tugboats operating in 1985. Towboats on the waterways can be divided into three categories, workboats or fleetboats and medium and high horsepower linehaul towboats. Each has unique requirements (Table 1.7). About 30 percent of the fleet are linehaul towboats propelling barges between ports and terminals on the inland waterway system. Most linehaul towboats on the inland waterway are over 100 feet long and some of the most powerful are almost 200 feet long.

Workboats and fleetboats are low horsepower vessels designed to handle and sort barges alongside terminals, to transport barges to and from fleet areas, and to break off or add on barges to linehaul tows moving in midstream. Crew accommodations are minimal and power ranges up to 1,500 horsepower. They comprise 70 percent of the fleet (2,200 boats), but only 30 percent of the total horsepower.

Medium horsepower linehaul towboats of 1500-5000 horsepower with single or twin screws handle the majority of multiple barge tows on all rivers in the inland waterways system. They comprise about one-fourth of the fleet (770 boats) with 42 percent of the total horsepower operating on the Mississippi River - GIWW system. Their average age in 1985 was 17-20 years. Linehaul boats frequently "turn-around" in the Cairo, Illinois, area, transferring barges to and from higher horsepower towboats working the Lower Mississippi.

High horsepower linehaul towboats of 5,000-10,500 horsepower, with twin or triple screws, move the largest tows in the relatively broad reaches of the inland waterway network, such as the Lower Mississippi and Ohio Rivers. Grain shipments have attracted 10,500 horsepower towboats to points as far north as Lock and Dam 21 on the Upper Mississippi River, about 140 miles above St. Louis. They comprise 6 percent of the fleet (220 towboats) with 28 percent of the horsepower. In 1985 their average age was 11-12 years.

TABLE 1.1

AGE DISTRIBUTION OF LOCK CHAMBERS ON FUEL TAX WATERWAYS BY SEGMENT*

RIVER SEGMENT	AGE (Years) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	>70	TOTAL
	NUMBER OF CHAMBERS								
UPP MISS	0	0	3	1	17	11	1	0	33
MID MISS	0	1	0	2	0	0	0	0	3
LOW MISS	4	19	1	0	0	0	0	0	24
ILLINOIS	0	0	1	0	2	5	0	0	8
OHIO	4	19	20	6	11	21	4	7	92
GIWW	1	0	3	16	0	1	0	0	21
MOBILE	10	4	3	1	1	0	0	0	19
AIWW	0	0	0	0	2	1	0	0	3
C-S-W	0	4	2	1	1	0	0	5	13
TOTAL	19	47	33	27	34	39	5	12	216

*Ages are as of 1987.

TABLE 1.2
DRY CARGO BARGE FLEET, 1950 - 1985, FOR
THE UNITED STATES AND THE MISSISSIPPI-GIWW REGION

Year	Total Number	Percent Change	Total Ton Capacity	Percent Change	Avg. Cap. /Barge	Percent Change
			United States			
1950	11,339	---	7,860,688	---	693	---
1955	12,400	9.4	9,685,485	23.2	781	12.7
1960	14,025	13.1	12,188,956	25.8	869	11.3
1965	14,241	1.5	14,607,733	19.8	1,026	18.1
1970	15,890	11.6	17,695,275	21.1	1,114	8.6
1975	21,876	37.7	25,525,996	44.3	1,167	4.8
1980	27,426	25.4	34,486,851	35.1	1,257	7.7
1985	29,287	6.8	38,633,297	12.0	1,319	4.9
1950-85		158.3		319.5		90.3
			Mississippi-GIWW Region			
1950	5,563	---	4,375,975	---	787	---
1955	7,466	34.2	6,454,542	47.5	865	10.0
1960	9,672	29.5	9,117,836	41.3	942	8.9
1965	10,679	10.4	11,131,581	22.1	1,042	9.6
1970	12,550	17.5	14,284,009	28.3	1,138	9.2
1975	17,345	38.2	21,031,652	47.2	1,213	6.6
1980	22,586	30.2	29,261,091	39.1	1,296	6.8
1985	24,442	8.2	33,071,147	13.0	1,353	4.4
1950-85		339.4		655.7		70.5

Source USA: Waterborne Commerce Statistics Center, WRSC-TL-85 Waterborne Transportation Lines of the U.S. 1985.

TABLE 1.3
MISSISSIPPI-GIWW REGION DRY CARGO BARGE FLEET
CHARACTERISTICS BY TYPE AND SIZE CATEGORY, 1985

Barge	Barges		Capacity in ton		Avg.	Avg.
Type and Size	Total	%	Total	%	Tons	Age
OPEN HOPPER						
Less than 170'	245	4	145,179	2	59	33
170' -180'	1,376	20	1,287,079	14	935	21
190' -200'	5,200	75	7,768,159	83	1,494	15
200' -225'	13	0	19,336	0	1,487	23
225' -250	64	1	131,214	1	2,050	10
250' -300'	12	0	33,724	0	2,810	22
	6,910	(28)	9,384,691	(28)	1,358	17
COVERED HOPPER						
Less than 170'	40	0	26,582	0	665	33
170' -180'	42	0	39,233	0	934	34
190' -200'	10,304	99	15,968,160	98	1,552	12
200' -225'	3	0	5,950	0	1,983	26
225'250'	10	0	38,344	0	3,834	15
250' -300'	7	0	20,462	0	2,923	14
Over 300'	8	0	179,800	1	22,475	19
Unknown	3	0				
	10,417	(43)	16,278,531	(49)	1,566	12
DECK/FLAT						
Less than 170'	1,589	68	810,141	39	524	24
170' -180'	120	5	165,351	8	1,401	21
180' -190'	21	1	33,260	2	1,584	21
190' -200'	506	22	719,896	35	1,431	20
200' -225'	28	1	50,685	2	1,877	32
225' -250'	69	1	170,398	8	2,582	18
250' -300'	16	1	70,982	3	4,436	12
Over 300'	3	0	64,800	3	21,600	14
	2,352	(10)	2,085,513	(6)	907	23
LASH/SEABEE						
Less than 170'	1,113	100	460,782	100	414	14
	1,113	(5)	460,782	(1)	414	14
OTHER/UNKNOWN						
Less than 170'	956	26	455,160	9	494	24
170' -180'	75	2	84,779	2	1,146	20
180' -190'	3	0	4,245	0	1,415	18
190' -200'	2,368	65	3,538,318	73	1,524	10
200' -225'	16	0	33,387	1	2,087	13
225' -250'	60	2	168,489	3	3,120	16
250' -300'	129	4	402,980	8	3,124	6
Over 300'	10	0	129,508	3	12,951	11
Unknown	21	1	16,358	0	1,487	9
	3,638	(15)	4,833,224	(15)	1,366	14
TOTAL	24,430	(101)	33,042,741	(99)	1,362	15

Source: WRSC-TL-85

TABLE 1.4
TANK BARGE FLEET, 1950-1985, FOR
THE UNITED STATES AND THE MISSISSIPPI-GIWW REGION

Year	Total Number	Percent Change	Total Ton Capacity	Percent Change	Avg. Cap. /Barge	Percent Change
			United States			
1950	2,050	---	2,634,090	---	1.285	---
1955	2,188	6.7	3,041,565	15.5	1,390	8.2
1960	2,429	11.0	3,716,925	22.2	1,530	10.1
1965	2,548	4.9	4,946,288	33.1	1,941	26.9
1970	3,281	28.8	6,332,749	28.0	1,930	-0.6
1975	3,524	7.4	8,201,561	29.5	2,321	20.3
1980	4,166	18.2	10,388,265	26.7	2,494	7.5
1985	4,252	2.1	10,842,430	4.4	2,550	2.2
1950-85		107.4		311.6		98.4
			Mississippi-GIWW Region			
1950	1,383	---	1,489,502	---	1,077	---
1955	1,513	9.4	2,284,878	5.1	1,510	40.2
1960	1,812	19.8	2,852,975	24.9	1,574	4.2
1965	2,031	12.1	4,037,480	41.5	1,988	26.3
1970	2,659	30.9	4,821,062	19.4	1,813	-8.8
1975	2,903	9.2	6,117,768	26.9	2,107	16.2
1980	3,445	18.7	7,147,532	16.8	2,075	-1.5
1985	3,529	2.4	7,317,728	2.4	2,074	-0.0
1950-85		155.2		391.3		92.6

Source: WRSC-TL-85

TABLE 1.5
MISSISSIPPI-GIWW REGION TANK BARGE FLEET
CHARACTERISTICS BY TYPE AND SIZE CATEGORY, 1985

Barge Type and Size	Barges Total	%	Tonnage Total	%	Avg. Tons	Avg. Age
COMPARTMENTED						
Less than 170'	215	16	270,175	10	1,293	21
170' -180'	57	4	95,302	3	1,672	20
180' -190'	21	2	42,551	2	2,026	16
190' -200'	564	42	855,291	30	1,522	18
200' -225'	61	5	109,165	4	1,790	25
225' -250'	123	9	308,458	11	2,549	18
250' -300'	294	22	1,028,363	37	3,510	18
Over 300'	6	0	85,786	3	14,298	12
Unknown	3	0	10,150	0	3,383	31
	1,344	(40)	2,805,241	(40)	2,104	19
NON-COMPARTMENTED						
Less than 170'	399	20	436,174	10	1,136	23
170' -180'	73	4	135,066	3	1,850	24
180' -190'	13	1	23,669	1	1,972	21
190' -200'	634	31	930,994	22	1,487	16
200' -225'	104	5	218,101	5	2,138	23
225' -250'	121	6	293,747	7	2,532	23
250' -300'	657	32	2,049,710	49	3,218	15
Over 300'	29	1	131,040	3	4,680	13
Unknown	3	0	1,341	0	1,341	10
	2,033	(60)	4,219,842	(60)	2,132	18
OTHER/UNKNOWN						
Less than 170'	2	33		0		4
190' -200'	3	50	2,900	70	967	28
200' -225'	1	17	1,254	30	1,254	29
	6	0	4,154	0	1,038	20
TOTAL	3,383	(100)	7,029,237	(100)	2,120	18

Source: WRSC-TL-85

TABLE 1.6
TOWBOAT - TUGBOAT FLEET, 1950-1985, FOR
THE UNITED STATES AND THE MISSISSIPPI-GIWW REGION

Year	Total Number	Percent Change	Total Horsepower	Percent Change	Avg. Hp. /Towboat	Percent Change
			United States			
1950	4,051	...	1,727,840	...	428	...
1955	4,162	2.7	2,083,576	20.6	501	17.1
1960	4,203	1.0	2,621,961	25.8	624	24.6
1965	4,054	-3.5	2,980,146	13.7	735	17.8
1970	4,248	4.8	3,858,563	29.5	908	23.5
1975	4,100	-3.5	5,088,221	31.9	1,241	36.7
1980	4,693	14.5	7,146,576	40.5	1,523	22.7
1985	4,954	5.6	8,030,407	12.4	1,621	6.4
1950-85		22.3		364.8		278.7
			Mississippi-GIWW Region			
1950	1,489	...	744,220	...	500	...
1955	1,752	17.7	1,026,318	37.9	586	17.2
1960	1,889	7.8	1,408,710	37.3	746	27.3
1965	2,023	7.1	1,698,312	20.6	840	12.6
1970	2,297	13.5	2,274,599	33.9	990	17.9
1975	2,404	4.7	3,226,545	41.9	1,342	35.6
1980	2,945	22.5	4,637,667	43.7	1,575	17.4
1985	3,220	9.3	5,153,940	11.1	1,601	1.7
1950-85		116.3		592.5		220.2

Source: WRSC-TL-85

TABLE 1.7
MISSISSIPPI-GIWW REGION TOWBOAT-TUGBOAT FLEET
CHARACTERISTICS BY HORSEPOWER CLASS, 1985

Horsepower Class	Boats Total	%	Horsepower Total	%	Avg. Hpr.	Avg. Age
Under 500	705	22	224,364	4	318	25
501-1000	1,104	34	856,402	17	776	16
1001-1500	383	12	467,431	9	1,220	16
1501-2000	270	8	478,635	9	1,773	20
2001-3000	182	6	465,471	9	2,558	19
3001-4000	180	6	629,022	12	3,495	20
4001-5000	136	4	604,640	12	4,446	17
5001-7000	173	5	1,019,306	20	5,892	12
7001-9000	38	1	306,348	6	8,062	12
Over 9000	10	0	102,321	2	10,232	11
Unknown	39	1		0		11
Total	3,200	100	5,153,940	100	1,620	18

Source: WRSC-TL-85

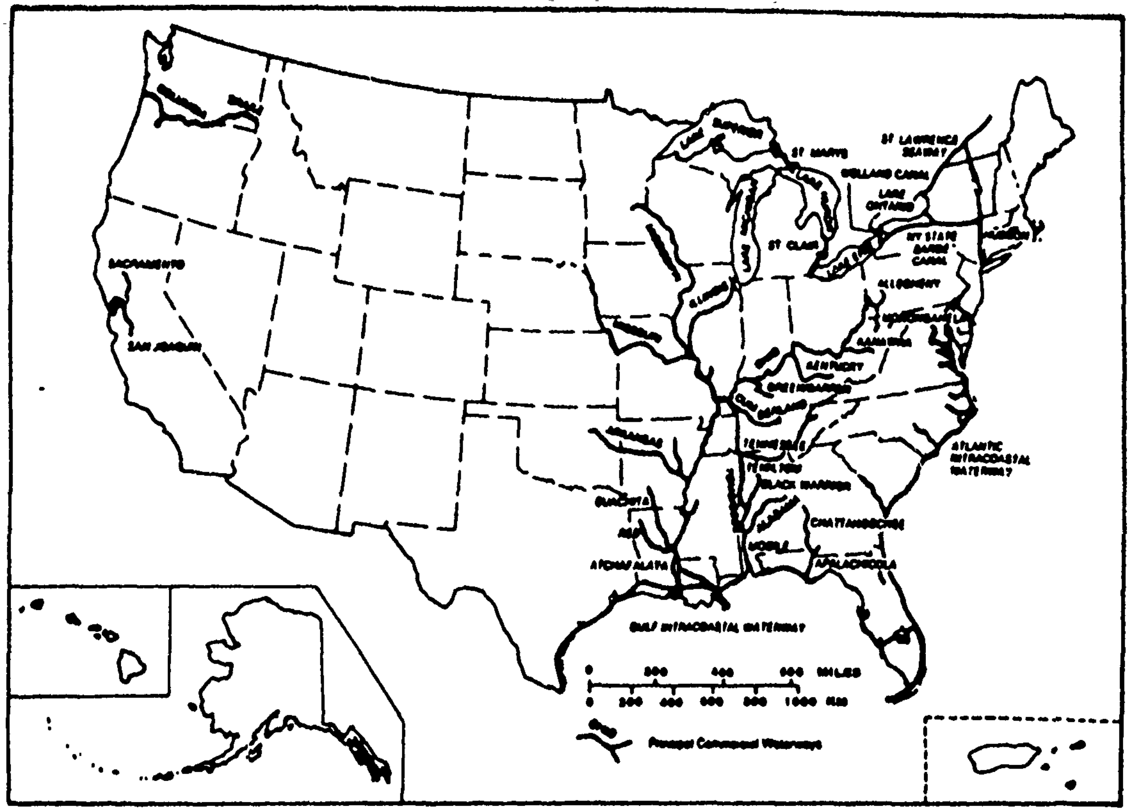


FIGURE 1.1
UNITED STATES PRINCIPAL COMMERCIAL WATERWAYS, 1986

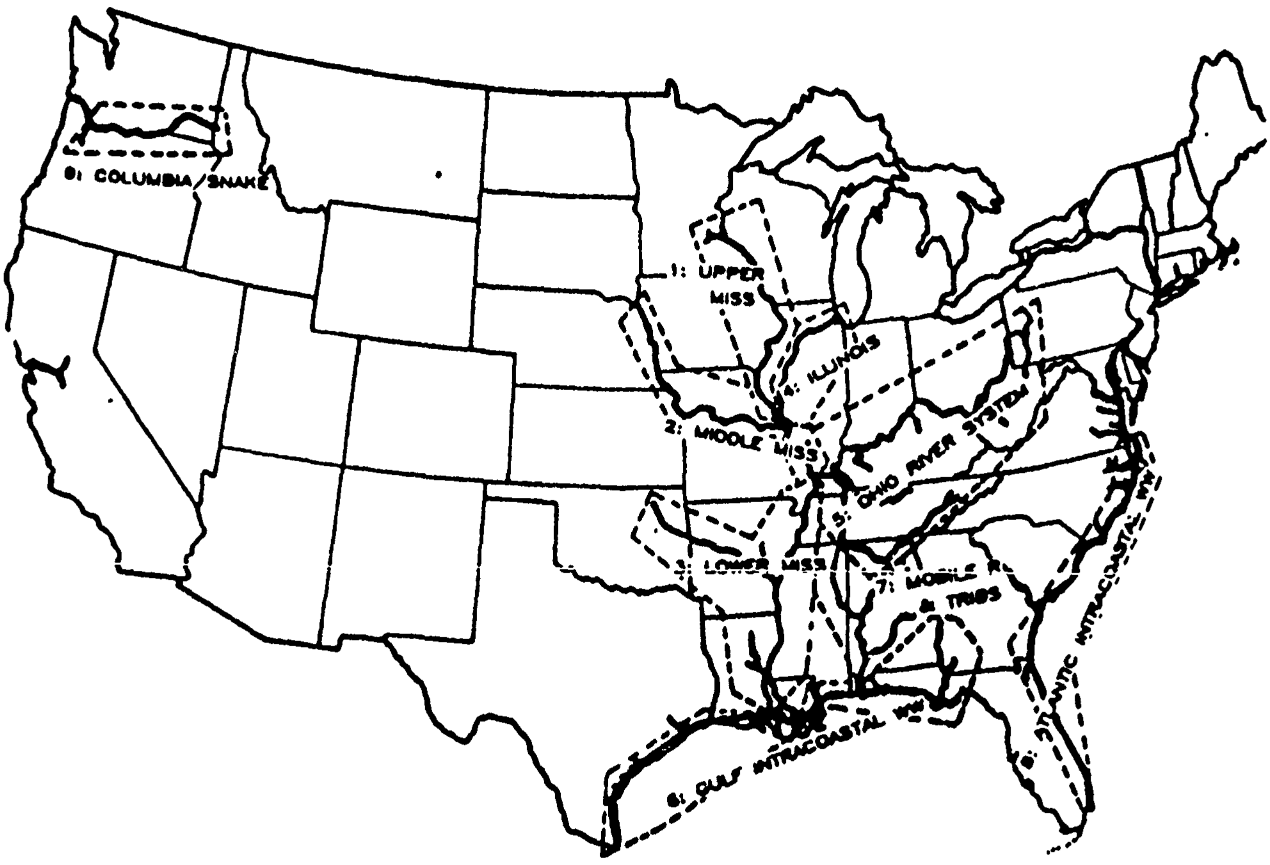


FIGURE 1.2
INLAND WATERWAY SEGMENTS

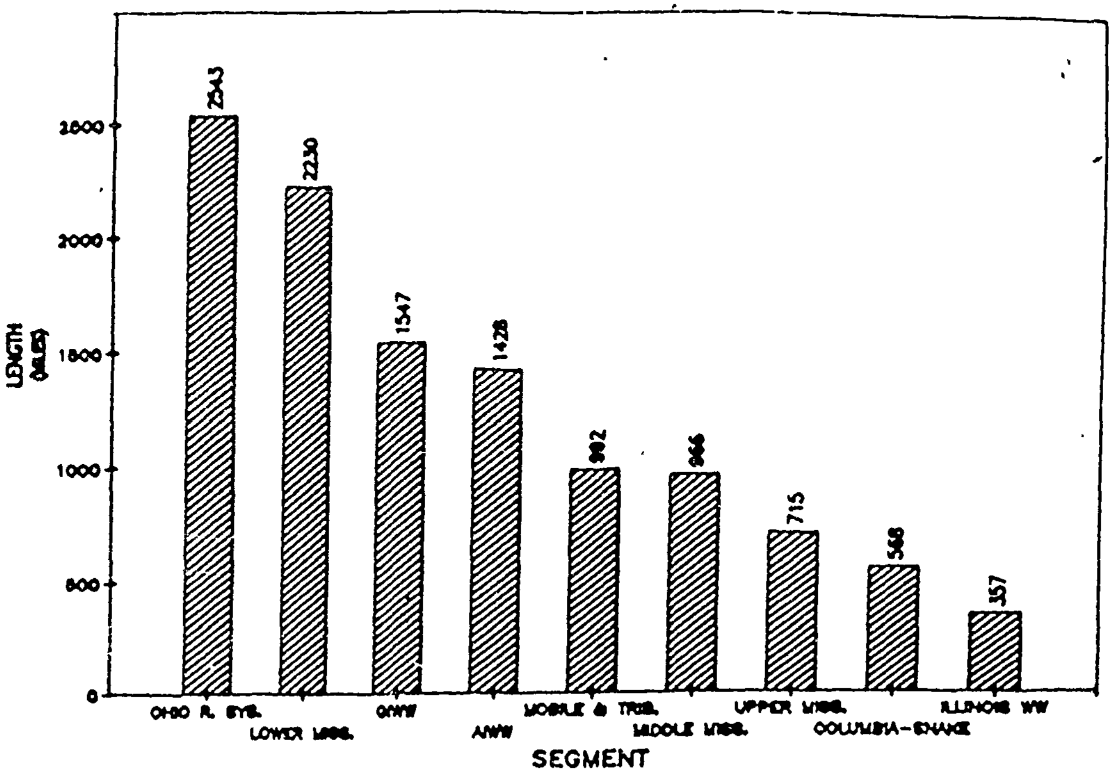
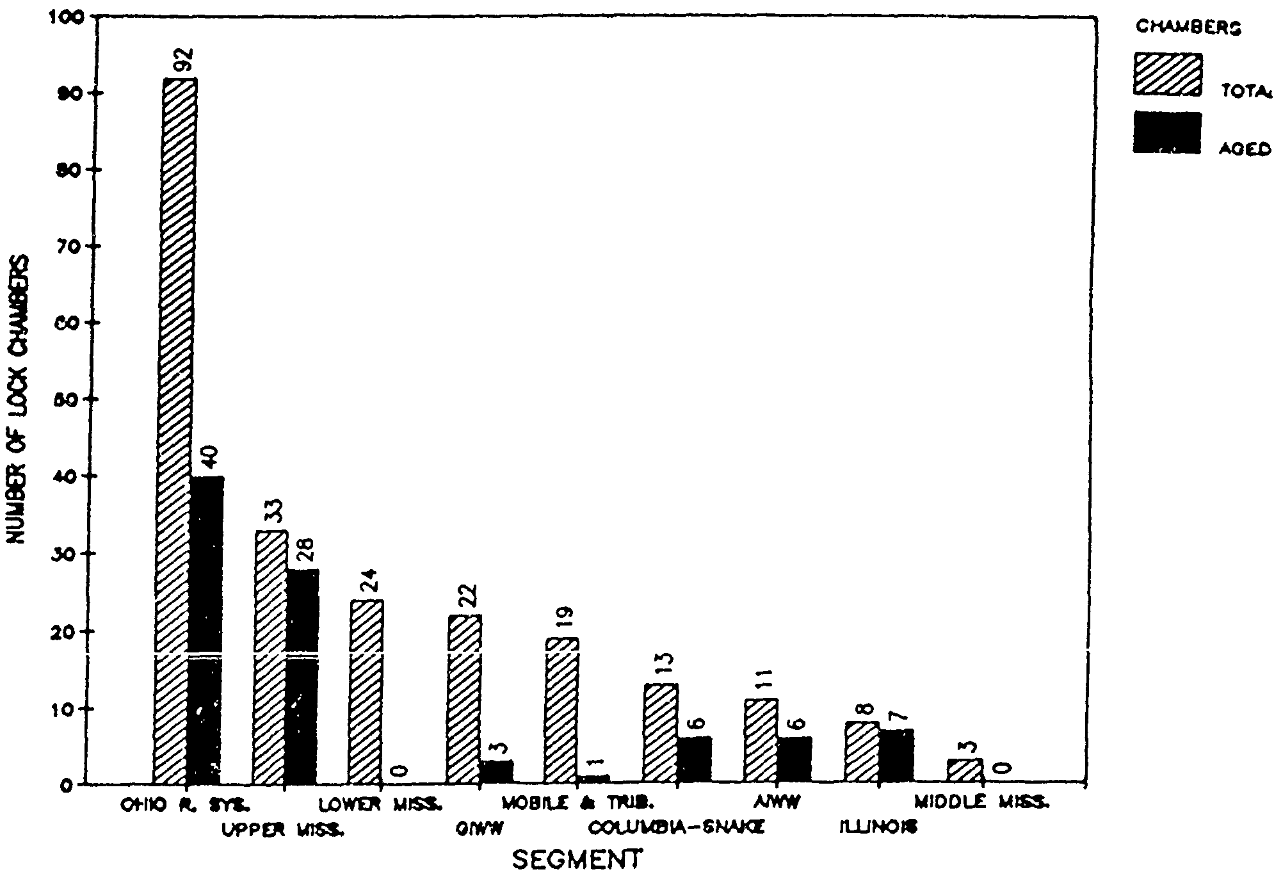


FIGURE 1.3

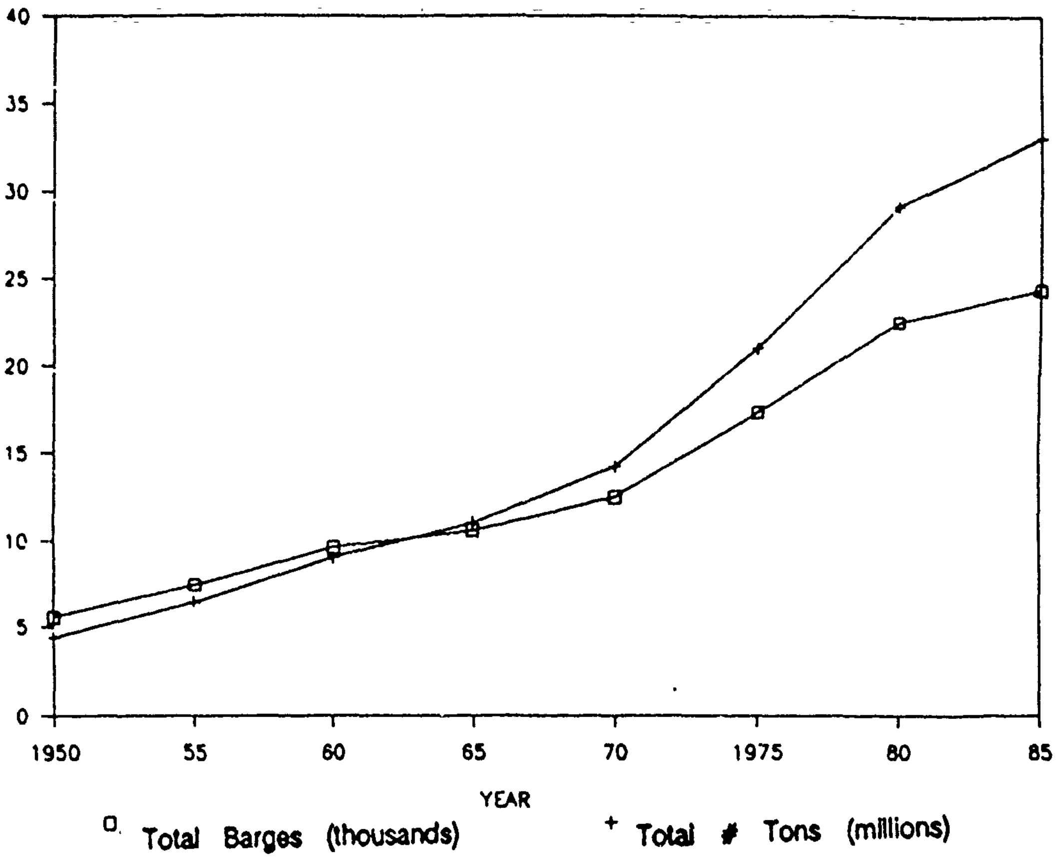
INLAND WATERWAY SYSTEM SEGMENT LENGTHS
(IN MILES)



GRAPHED BY CEWRC-IWP

FIGURE 1.4

TOTAL AND AGED (50+ YEARS OLD) LOCK CHAMBERS ON THE INLAND WATERWAY SYSTEM



MISSISSIPPI-GIWW DRY CARGO BARGE FLEET

FLEET SIZE AND CAPACITY

FIGURE 1.5

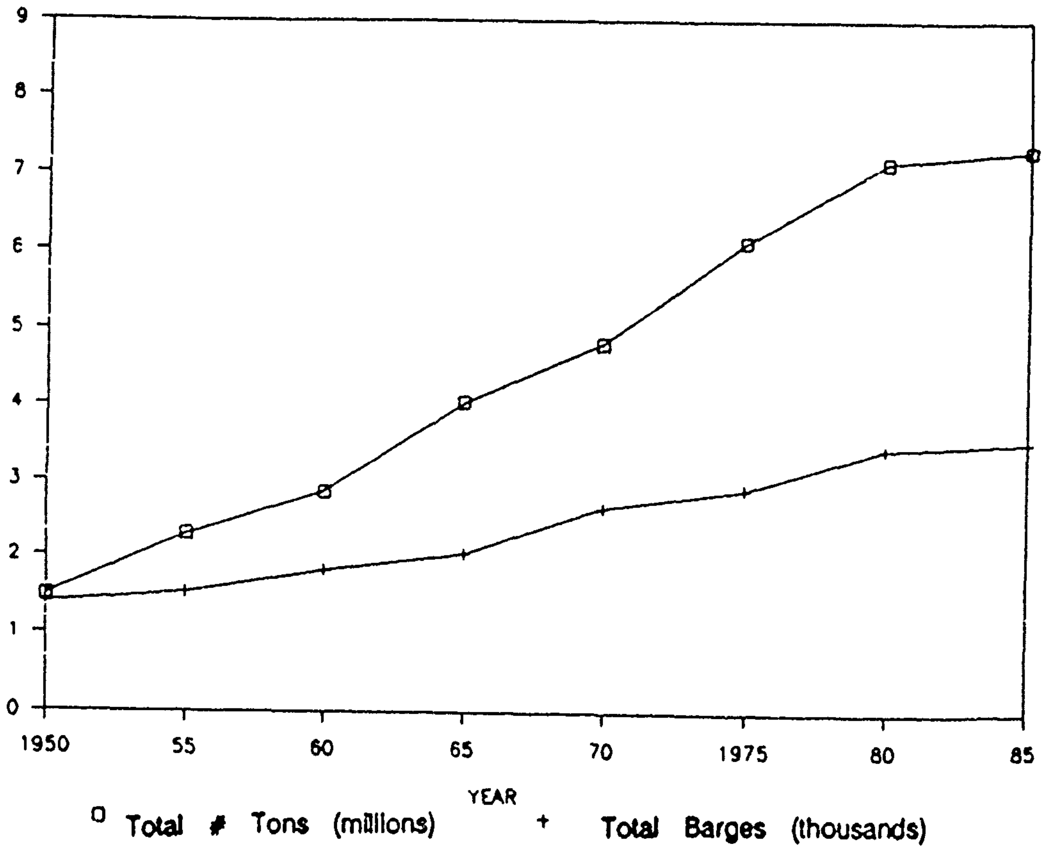


FIGURE 1.6

MISS-GIWW LIQUID CARGO BARGE FLEET

FLEET SIZE AND CAPACITY

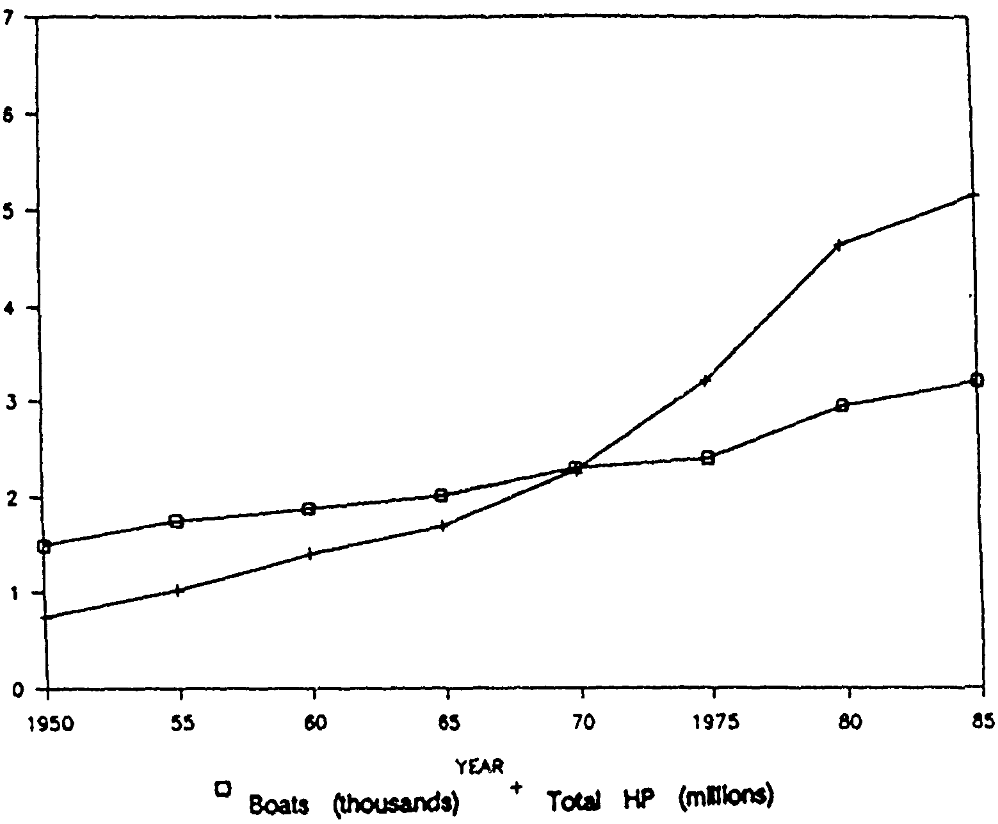


FIGURE 1.7

MISS-GIWW TOWBOAT-TUGBOAT FLEET

FLEET SIZE AND CAPACITY

Source: WRSC-TL-85

Chapter 2

INLAND WATERWAY TRAFFIC: HISTORIC TRENDS AND PROJECTIONS

INTRODUCTION

In 1986, a record 560 million tons of commerce were moved on the inland and intracoastal waterway system. This tonnage was more than triple the level of traffic in the years immediately following World War II. Most of the traffic is composed of liquid and dry bulk commodities, such as petroleum and its products, coal, grain and other farm products, industrial and agricultural chemicals, metal products, and sand, gravel and other nonmetallic minerals.

The inland waterways carry about half of the U.S. grain exports and one-fifth of the U.S. coal exports. By moving large volumes of these commodities at a low unit cost per ton, the waterway system helps to make our exports more price competitive. It also contributes to the economies of many individual states and to the nation as a whole through providing jobs, income and production.

In addition, the system would have vital importance during a military mobilization because of its ability to move huge quantities of fuel, strategic materials, and military equipment.

The following sections present a discussion of historic inland waterway traffic through 1986 and projected tonnage through the year 2000. Significant developments by commodity and waterway are highlighted. Historic traffic data are from the U.S. Army Corps of Engineers' Waterborne Commerce Statistics Center (WCSC) in New Orleans. Projected traffic was developed by IWR using trend analysis and economic sector growth indices from various sources, including Data Resources (DRI), WEFA Group (formerly Wharton and Chase Econometrics), U.S. Department of Agriculture (USDA), U.S. Department of Energy (DOE), and trade associations. A detailed discussion of the forecasting methodology is provided in the Appendix. The ten major commodity groups analyzed are:

1. Farm Products
2. Metallic Ores, Products and Scrap
3. Coal
4. Crude Petroleum
5. Nonmetallic Minerals/Products
6. Forest Products
7. Industrial Chemicals
8. Agricultural Chemicals
9. Petroleum Products
10. All Other

TOTAL TRAFFIC

Historic

Total traffic on U.S. shallow draft inland and intracoastal waterways (defined here as "internal" traffic) increased steadily after the end of World War II, at a robust average annual growth rate of 4.2 percent, until the 1978-80 period. Figures 1 and 2 show total U.S. internal traffic, historic and projected. A drop in waterway traffic occurred after 1980 due to a combination of factors, including an overall economic downturn in the United States and many other countries, a substantial restructuring in basic manufacturing industries, increased energy conservation, and reduced coal and grain exports. Renewed growth in traffic volumes began in 1984, stimulated by economic recovery and extremely low barge rates. The recovery in waterway traffic faltered briefly in 1985 as coal and grain traffic fell, but 1986 and preliminary

1987 statistics indicate that growth has resumed. The falling value of the U.S. dollar, lower petroleum prices and agricultural support programs have stimulated domestic industrial activity and increased farm exports.

Several important commodity groups comprise the vast majority of tonnage moving on the inland waterways as can be seen in Figures 1 and 2.1 and Table 2.1. The major commodities and their share of 1986 traffic are coal (29%); crude petroleum and petroleum products (27%); nonmetallic minerals and products (13%); farm products (12%); and industrial and agricultural chemicals (8%). A mixture of other commodities, including forest products, metallic ores, products and scrap, and a variety of specialty cargos comprise the remainder.

Coal traffic has varied over the past decade from a low of less than 115 million tons in the miners' strike year of 1978, to over 163 million tons in 1986, the highest level ever on the inland waterways. Growth has been particularly dramatic since 1983 when economic recession and reduced coal exports resulted in inland waterway coal traffic of less than 126 million tons. The 1986 tonnage figures indicate an increase of 37 million tons, or nearly 30%, since that year. This high growth rate has been induced by strong economic recovery since the recession, coupled with extremely low barge rates in an industry beset with excess capacity. As a result, the waterway's share of coal transportation has increased.

Farm products traffic on the inland waterways reached its peak at the national level in 1982, when over 85 million tons moved on the system, driven by rapid growth in U.S. grain exports. These grain exports began to fall by 1983 due to the high value of the dollar, increased competition from other nations, and intense European Economic Community (EEC) subsidization of their farm sector which turned the EEC from net importers into net exporters. By 1986 farm products traffic on the inland waterways had fallen to 67.6 million tons, the lowest level since 1979. However, the introduction of grain export subsidies to compete with those of the EEC, the falling value of the U.S. dollar in general, and reduced crop yields in some countries (USSR, China, India), have combined to stimulate grain exports in 1987. Wheat exports have increased over 50% from 30 to about 45 million tons between 1986 and 1987. Total wheat, corn and soybean exports have increased about 23% from 95 to 117 million tons. Since much of this export grain and oilseed traffic moves on the inland waterways (historically about 50%), 1987 statistics, when they become available, should show a significant upturn in inland waterway farm products movements.

Waterway traffic in crude petroleum and petroleum products increased in 1986 to 43.9 and 107.5 million tons, respectively. Crude had peaked in 1978 at 50.5 million tons before falling to a low of 34.7 million in 1982. While crude movements have grown each year since then, the collapse of oil prices in 1986 and the ensuing fall in domestic production are expected to blunt this trend. Inland waterway movements of petroleum products peaked in 1977 at nearly 128 million tons, but fell each year after that to a low of less than 99 million in 1983, reflecting the combined effects of lower overall demand, increased conservation, the downturn in the economy, and greater reliance on pipeline transportation. While tonnage has grown since then with the onset of economic recovery and diminishing returns from conservation efforts, traffic in petroleum products is expected to grow slowly at best.

Chemical traffic on the inland waterways has generally grown since the recession period of 1982. Industrial chemicals have increased each year from 23.2 million tons in 1982 to a new peak of 32.9 million tons in 1986. Agricultural chemicals, sensitive to fluctuations in the farm sector, declined slightly in 1985. Otherwise this chemical group also increased every year since 1982, growing from 7.3 million tons to a record 12.8 million in 1986. The strong domestic

economy and increasing exports for both chemical groups due to the weaker dollar should result in continued growth.

Among other commodity groups on the inland waterways, forest products traffic rebounded in 1986 to over 20 million tons, the highest level since 1980. Strong domestic and export demand for lumber, pulp, paper and other wood products should sustain this growth trend. The cyclical nonmetallic minerals and products group, sensitive to construction industry trends, recorded tonnages over 75 million in 1985 and 1986--the highest levels since 1979. Metallic ores, products and scrap, while below historic levels of the late 1970s, has recovered impressively from a recession low of 8.2 million in 1982 to over 14.9 million in 1986.

Projections

As can be seen in Figure 2 and Table 2.2, total traffic on inland and intracoastal waterways is projected to experience modest but steady growth under all growth rate assumptions. Yearly fluctuations in response to current economic conditions and the volume of coal and grain exports are, of course, inevitable. Recent projections do not reflect the optimism that was evident in the high growth rates that were forecast in the late 1970s and early 1980s, but they do anticipate modest sustained growth through the year 2000. In Table 2.2, the sums of individual commodity forecasts result in projected average annual growth rates for total traffic ranging from 0.7% (low) to 1.5 (medium) and 2.1% (high). Forecasts for total internal waterway traffic in 2000 range from a low of 620.1 million tons to a medium of 686.6 and a high of 748.2 million tons.

The commodities with the highest forecasted growth rates are industrial and agricultural chemicals, farm products and coal. These commodity groups are expected to grow at average annual rates of 1.3 to 3.7%. The two chemical groups are driven by both strong domestic and export demand. From 1986 to 2000 industrial chemicals are projected to increase 20 to 53%; while agricultural chemicals grow from 23 to 57%. Farm products traffic is forecast to grow sharply in the near term due to higher exports, and then more slowly after the early 1990s, ultimately increasing 40 to 66% by 2000. Coal traffic is expected to continue recent growth on the waterways, particularly to meet increasing utility demands. Coal is expected to increase 30 to 55 percent by 2000.

Forest products traffic is expected to grow modestly over the period at an annual rate of 0.9 to 1.9 percent. Petroleum products are projected to remain nearly flat under low scenario assumptions but grow at a moderate 0.7 to 1.2 percent under the medium and high scenarios, respectively, as relatively low prices slow but steady increases in demand.

Traffic levels in metallic ores, products and scrap, nonmetallic minerals and products, crude petroleum, and the "all other commodities" categories are forecast to be generally flat or declining over the period, with average annual growth rates ranging from +1.2% to -3.3%.

WATERWAY SEGMENT TRAFFIC: HISTORIC AND PROJECTED

This review examined 16 portions of inland and intracoastal waterways contained within 9 major waterway segments. Each of these waterways is examined in detail in the Appendix. Highlights of their historic and projected traffic are discussed below and depicted in Figures 2.2-2.17. Waterways exhibiting significant positive linear trends are shown with a 95 percent statistical prediction interval about the historic data and projected to 2000. Actual projections may fall outside these bands depending on fluctuations of major commodity groups. Historic traffic for selected years between 1965-1986 on these segments and subsegments is shown in

Table 2.3, while projected tonnages are in Table 2.4. The Ohio River (main stem), the Lower and the Middle Mississippi, and the Gulf Intracoastal Waterway (GIWW) have historically carried the highest volumes of waterborne commerce. These waterways are followed in tonnage by the Upper Mississippi, the Illinois and the Tennessee rivers.

Upper Mississippi

Total tonnage climbed slightly on the Upper Mississippi River between 1985 and 1986 to 73.7 million tons (Figure 2.2). Continued low farm products traffic was only partially offset by record high movements of coal, nonmetallic minerals and products, industrial chemicals, and metallic ores, products and scrap. However, despite the increases for most commodity groups, the lackluster performance of farm products traffic kept total Upper Mississippi tonnage well below the peak years of 1983 and 1984. The upturn in U.S. grain exports in 1987 and 1988 have increased farm products movements on this waterway according to data collected by the Lock Performance Monitoring System (PMS). Petroleum products traffic was at its highest level since 1979. Crude petroleum continued a long decline, dropping to the lowest level since 1975.

Traffic projections for the Upper Mississippi are driven by recovery and growth in farm products traffic in particular (53% of total), as well as increases in coal and industrial and agricultural chemicals. Total traffic is projected to increase from 73.7 mst in 1986 to between 93.3 and 112.4 million tons by 2000. Farm products movements are forecast to continue to grow, as U.S. grain exports recover world market share. Coal traffic is also projected to continue to grow at a moderate rate in the future. Industrial and agricultural chemicals are both expected to continue moderate growth rates.

Middle Mississippi and Missouri Rivers

The Middle Mississippi carried nearly 98 million tons in 1986, up by over 5 mst from 1985, but still below the high of 104 million tons in 1984 when farm products movements were considerably stronger (Figure 2.3). Farm products movements peaked in 1983 at nearly 56 million tons (57% of total), before beginning a decline to 40.2 million tons in 1986 (41% of total). The recovery in grain exports pushed 1987 tonnages up considerably, based on PMS data. Coal, the next largest commodity group, has generally been increasing since the coal miners' strike-year low of 8.6 million tons in 1978. Coal traffic reached 21.5 million tons in 1986 and this increasing coal tonnage has kept total waterway traffic from falling very much even while grain traffic dropped.

Traffic on the Missouri River reached nearly 7 million tons in 1986, the highest level since 1979, when grain movements peaked (Figure 2.4). The recent increases in tonnage are due to nonmetallic minerals and products, which reached an all-time high in 1986 (64% of total).

Projections of traffic on the Middle Mississippi are for moderate growth from 98 million tons in 1986 to between 120.3 and 144.8 million tons by 2000. Farm products and coal will continue to be the dominant commodities. Farm products and coal are the driving forces in the projections and account for most of the growth. Petroleum products show little or no growth. Traffic in agricultural chemicals is projected to show considerable growth.

Missouri River projections are for slow growth during the remainder of the century, increasing from 7 to 9.4 million tons under the high scenario. However, historic fluctuations on this segment suggest traffic could also decline under low scenario assumptions to 6.2 million tons by 2000. Traffic on this waterway is depressed by the high percentage of nonmetallic

minerals and products. Farm products and agricultural chemicals are expected to show the most growth on the Missouri by 2000.

Lower Mississippi and Arkansas Rivers

The Lower Mississippi carried over 156 million tons in 1986, a gain of 6 million over 1985 (Figure 2.5). The Lower Mississippi has sustained nearly steady traffic growth over the past decade, increasing at an average annual rate of 2.6% since 1977. Tonnage is dominated by farm products (36% in 1986), followed by coal (21%) and petroleum products (12%). Coal tonnage has been growing continuously over the past decade. Coal and industrial and agricultural chemicals all reached record highs in 1986.

Tonnage on the Arkansas River also increased in 1986, growing to 8.4 million tons from 7.7 million in 1985 (Figure 2.6). Traffic on the Arkansas is mostly farm products, agricultural chemicals and nonmetallic minerals and products. Petroleum products, 23% of total traffic when it peaked at over 2 million tons in 1977, has since declined to just under .85 million tons in 1986.

Projections for the Lower Mississippi anticipate relatively strong growth through 2000 from increases in farm products, industrial and agricultural chemicals, coal, and, under the high scenario, petroleum products. Tonnage is forecast to increase from 156 million tons in 1986 to between 189.5 and 234 million tons in 2000.

Tonnage on the Arkansas River is projected to grow from 8.4 million tons in 1986 to between 9.6 and 15.5 million tons in 2000. Farm products, agricultural chemicals and nonmetallic minerals and products continue to dominate traffic on the waterway. Agricultural chemicals increase by 50% under the high scenario by 2000.

Illinois Waterway

Traffic on the Illinois Waterway began to falter in the late 1970s and into the recession years of the early 1980s as the traditional heavy industries of this region fell on hard times (Figure 2.7). Increasing farm products traffic helped offset declines in coal, petroleum products, metallic products and scrap, and industrial chemicals. Total tonnage in 1986 was 42.3 million tons, up over 4 million from the previous year as traditional commodity groups began to strengthen, although grain traffic fell to its lowest level since 1979.

Projections of traffic on the Illinois Waterway anticipate moderate growth through 2000. Total tonnage is expected to increase from 42.3 million tons to between 50.1 and 60.1 million tons by the turn of the century. Strong growth in farm products, coal, and industrial account for most of the growth on the Illinois.

Ohio River System

The Ohio River System (the main stem and its navigable tributaries) has shown dramatic traffic growth in recent years, passing 200 million tons in 1984 and over 222 million tons in 1986 (see Figure 2.8). This total tonnage figure is 30% higher than the recession year low of 171 million tons in 1983. Coal has generally accounted for 55-60% of total Ohio River System traffic over the past decade, and an even higher percentage on some of the tributaries. Strong growth has occurred on the main stem of the Ohio, up nearly 11% between 1985 and 1986, to 196 million tons. An even higher growth rate was evident on the tributary Kanawha, which increased nearly 15% during the same one-year period from 14.6 to 16.8 million tons (75%

coal). (See Figures 2.9 through 2.13 for historic and projected traffic on the Ohio and its tributaries.) Other tributaries have also shown significant growth, including the Tennessee (up 8.5% from 36.5 to 39.6 million tons) and the Monongahela (up 2.7% from 28.8 to 29.5 million tons). Record high traffic on the Cumberland in 1986 reflected a temporary diversion of traffic around the Kentucky Lock on the Tennessee River while it was undergoing major rehabilitation; however, 1985 statistics indicated continued recovery in tonnage on this waterway also. Booming coal traffic serving the electric utility industry accounts for much of the traffic on the Ohio River and its tributaries and this has created growth rates relatively higher than national averages (an annual rate of 2.5% since 1977).

Projections of traffic on the Ohio River System reflect modest sustained growth under all scenarios through 2000. Total traffic on the system is projected to increase from 222 million tons in 1986 to between 266.8 and 327.0 million tons by 2000. On the main stem, traffic is expected to increase from 196 million tons in 1986 to between 233.7 and 288.7 million tons by 2000. Coal continues to be the primary commodity and assumptions about the share of coal traffic moving on the waterways drive the differences in tonnage between the low and high scenarios.

Total tonnage on the Monongahela is expected to increase from the depressed level of 30 million tons in 1986 to between 43.1 and 56.2 million tons by 2000 (87% coal). Traffic on the Kanawha is projected to grow from 17 million tons in 1986 to between 21.2 and 28.4 million tons by 2000 (about 75% coal). Cumberland River traffic is also forecast to have moderate increases in total traffic, with coal and nonmetallic minerals comprising the largest commodity shares. Total traffic is expected to increase from 14 million tons in 1985 to between 17 and 23.7 million tons by 2000. The Tennessee River is also forecast to show moderate growth through 2000, driven mainly by coal, farm products and chemicals. Traffic on the Tennessee has exhibited strong growth since the 1982-83 recession period, increasing from less than 26 million tons in 1982 to nearly 40 million tons in 1986--a record level. Tonnage is forecast to increase to between 47.1 and 56.6 million tons by 2000.

Gulf Intracoastal Waterway

The Gulf Intracoastal Waterway ranked third in tonnage in 1986 after the Ohio and the Lower Mississippi. The waterway reached nearly 106 million tons, the highest level since 1972 when the GIWW carried 109 million tons. This volume of traffic demonstrated a strong recovery from the 1982 low of 82 million tons when oil shocks followed by recession had taken a major toll in GIWW traffic (Figure 2.14). Petroleum products dominate GIWW traffic, reaching a new high of 37 million tons in 1986 (35% of total). Crude petroleum tonnage recovered to 1979 levels, while industrial chemicals continued a strong post-recession recovery. Coal tonnage, while smaller than the other commodities, has exhibited steady growth and is more than double its 1983 level.

Forecasts for the GIWW range from a slight decline in traffic under the low scenario (to 101.7 million tons in 2000) to moderate growth under the high projection (to 131 million tons in 2000). This variation is due to the waterway's high proportion of crude petroleum and petroleum products, commodities for which traffic projections can be particularly volatile. The projections were adjusted to take into account the historic fluctuations in traffic volume. Crude is projected to decline at varying rates under all scenarios, while products range from nearly flat growth under the low to modest growth under the high scenario. Moderate to strong growth is projected for industrial chemicals and coal, driving growth under the high scenario. A more detailed analysis of future movements on the GIWW will be conducted during preparation of Regional Plans in 1989.

Black Warrior/Tombigbee Waterway

Traffic on the Black Warrior/Tombigbee Waterway declined to 17.9 million tons in 1986 (see Figure 2.15) after a peak in 1984 at 19.6 million tons, a year when coal movements--the dominant commodity--were also at record levels. Coal movements declined to the lowest level since 1981, reflecting declining export traffic. The current growth commodity on the waterway is forest products, which increased to 2.8 million tons in 1986. As recently as 1983, only about 230 thousand tons of forest products were moving on the system, but the opening of a new plant in Mobile has stimulated tremendous growth since then. Movements of metallic ores, products and scrap for the steel industry collapsed between 1976 and 1982. Economic recovery and the restructuring of the industry has resulted in a partial rebound of this traffic.

Projections of traffic on the Black Warrior/Tombigbee Waterway show moderate growth through 2000 from higher coal movements after and small increases in forest products movements. Total traffic is forecast to Figure 23 increase from 17.9 million tons in 1986 to between 25.3 and 30.2 million tons by 2000. Coal traffic recovers strongly under high scenario assumptions, generating most of the traffic growth. Recent rapid growth in forest products movements quickly matures in the near term and grows more slowly in out years.

Atlantic Intracoastal Waterway

Traffic on the Atlantic Intracoastal Waterway (AIWW) grew significantly in 1986 to nearly 4.4 million tons, up from 3.1 million tons in 1985 to the highest level since 1979 (Figure 2.16). Increases were due primarily to sharply higher, but localized, movements of agricultural chemicals and nonmetallic minerals and products, particularly along the North Carolina coast. Nonmetallic minerals and products and agricultural chemicals both achieved new highs in 1986. Growth also occurred in industrial chemical and metallic ore, product and scrap movements, while forest products continued a long term decline.

Projections of traffic on the AIWW anticipate continued strength in agricultural chemical movements, dominated by localized movements of phosphate rock to Morehead City, N.C. for both domestic use and export. Total traffic on the waterway is expected to increase from 4.4 million tons in 1986 to between 5.7 and 8.1 million tons in 2000. Of this total about 4 million tons is projected to be agricultural chemicals. The projection envelope has been adjusted to account for historic wide fluctuations on this waterway.

Columbia River

The Columbia River transported 14.1 million tons in internal (shallow draft) waterborne commerce in 1986 (Figure 2.17). This was a small increase from the previous year and well below the 1980 peak of 19.1 million tons. Lower farm and forest products movements account for much of the decline in total tonnage since 1980. However, improvement in grain and log exports from the Pacific Northwest are reflected in higher traffic levels at locks in 1987.

Projections for this waterway anticipate a recovery in traffic as movements of farm products and forest products for export regain their former strength. Total waterway traffic is forecast to grow from 14.1 million tons in 1986 to between 17.3 and 24.7 million tons by 2000. Forest products increase significantly by 2000, due to exports to the Far East market, but remain below tonnages achieved in the mid-1970s. Farm products are projected to increase to levels near or slightly above the traffic volume during peak grain export years of the early 1980s by the year 2000.

CONCLUSIONS

Total internal waterborne commerce in 1986 reached record levels and reflected the strength and continued growth of the economy out of the recession years of the early 1980s. While the recent recovery in grain exports will not be reflected until 1987 statistics are available, the vigorous growth in coal, petroleum products, industrial and agricultural chemicals, and forest products during 1986 indicate that inland waterway traffic has resumed its long term growth trend. The nation's economic growth, combined with very low barge rates due to excess capacity in the industry, attracted record volumes of traffic for coal in particular. Inland waterways with a high proportion of coal traffic, such as the Ohio River and its tributaries, consequently reflect much higher growth rates than some other waterways in 1986.

Projections of inland waterway traffic are tied to the general well being of the economy as well as the changing fortunes of various commodity groups and to the competitiveness of the barge industry. However, generally modest growth is expected across all waterways over the next two decades, as evidenced by the 1.5% annual growth rate under the medium scenario.

Farm products traffic will increase sharply in the near term due to recent grain export enhancement programs, particularly affecting traffic on the Illinois, the Missouri, the Arkansas, and the full length of the Mississippi. Longer term projections for farm products traffic are uncertain due to the policy element, but modest growth should continue through the turn of the century due to the food demands of a growing world population.

Coal traffic is expected to experience only modest growth in the near term as several nuclear power plants come on line, steel industry demand remains flat, and export demand faces continued strong foreign competition. However, higher growth rates are likely after the early 1990s as the utility industry returns to coal to meet long term increases in demand. Coal traffic, therefore, is likely to grow more slowly than it has in recent years, but will return to a higher growth rate in the 1990s, affecting traffic on the Ohio River System, the Black Warrior/Tombigbee, and Middle Mississippi and Illinois rivers in particular.

Probable declines in domestic petroleum production will result in a reduction in traffic in crude petroleum and a slower growth rate for petroleum products, affecting total tonnages on such waterways as the Gulf Intracoastal and the Lower Mississippi.

In general, however, all waterways benefit to some extent from renewed positive growth on the inland and intracoastal waterway system.

TABLE 2.1
U.S. INLAND WATERWAY TRAFFIC
TOTAL COMMODITY MOVEMENTS, 1975 - 1986
(MILLION TONS)

TOTAL TRAFFIC	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
FARM PRODUCTS	46.1	57.5	55.3	61.5	63.9	74.7	78.1	85.3	84.7	80.0	70.6	67.6
METALLIC ORE/PROD/SCRAP	14.0	16.6	16.4	16.8	17.8	15.1	14.8	8.2	8.8	12.5	14.1	14.9
COAL	125.3	128.0	127.6	114.6	125.7	131.6	138.8	131.0	125.8	154.4	147.1	163.1
CRUDE PETROLEUM	47.6	47.5	48.6	50.5	47.2	41.6	35.3	34.7	35.5	38.7	40.9	43.9
NONMETALLIC MINRL/PROD	72.7	66.2	67.7	76.5	76.9	68.6	58.8	56.3	60.0	70.3	75.6	75.2
FOREST PRODUCTS	23.4	23.7	22.9	22.8	20.4	22.2	18.6	16.4	15.7	19.1	17.6	20.1
INDUSTRIAL CHEMICALS	23.8	26.0	26.4	27.3	29.6	28.1	27.0	23.2	25.3	29.0	29.6	32.9
AGRICULTURAL CHEMICALS	6.5	6.5	7.9	8.2	8.6	9.0	8.1	7.3	10.5	12.4	11.2	12.8
PETROLEUM PRODUCTS	109.5	120.9	127.9	126.3	118.7	116.7	111.1	101.9	98.9	103.5	100.4	107.5
ALL OTHER COMMODITIES	35.1	31.1	28.1	30.0	26.3	27.4	30.2	31.2	21.9	22.6	27.5	22.5
TOTAL	503.9	524.0	528.7	534.5	535.0	535.0	520.7	495.5	487.1	542.5	534.7	560.5

SOURCE: WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL

TABLE 2.2
U.S. INLAND WATERWAY TRAFFIC
PROJECTIONS OF TOTAL COMMODITY MOVEMENTS
(MILLIONS OF TONS)

TOTAL TRAFFIC	ACTUAL 1986	1990 LOW	1990 MEDIUM	1990 HIGH	1995 LOW	1995 MEDIUM	1995 HIGH	2000 LOW	2000 MEDIUM	2000 HIGH	ANN % TO 2000 LOW	ANN % TO 2000 MED	ANN % TO 2000 HIGH
FARM PRODUCTS	67.6	81.6	83.1	86.9	87.9	93.1	99.3	94.7	102.3	112.0	2.4%	3.0%	3.7%
METALLIC ORE/PROD/SCRAP	14.9	14.1	15.2	17.2	13.8	14.7	17.0	13.5	13.9	17.0	-0.7%	-0.5%	0.9%
COAL	163.1	175.9	180.2	184.8	193.2	204.0	216.0	212.3	231.1	252.5	1.9%	2.5%	3.2%
CRUDE PETROLEUM	43.9	35.4	37.2	39.7	28.8	33.7	37.0	26.3	32.7	34.5	-3.6%	-2.1%	-1.7%
NONMETALLIC MIN/PROD	75.2	69.9	76.0	77.5	68.3	77.9	79.9	69.4	79.9	81.9	-0.6%	0.4%	0.6%
FOREST PRODUCTS	20.1	20.6	21.2	24.4	21.4	23.3	24.8	22.7	24.9	26.1	0.9%	1.5%	1.9%
INDUSTRIAL CHEMICALS	32.9	33.3	34.7	35.7	36.2	39.9	42.4	39.4	45.8	50.3	1.3%	2.4%	3.1%
AGRICULTURAL CHEMICALS	12.8	12.3	12.9	14.4	14.2	15.0	17.2	15.7	17.4	20.1	1.5%	2.2%	3.3%
PETROLEUM PRODUCTS	107.5	107.6	113.0	116.8	108.3	115.4	122.2	108.7	117.8	127.1	0.1%	0.7%	1.2%
ALL OTHER COMMODITIES	22.5	22.0	23.2	24.9	19.5	21.9	25.8	17.4	20.8	26.7	-1.8%	-0.6%	1.2%
TOTAL	560.5	572.7	596.7	622.3	591.6	638.9	681.6	620.1	686.6	748.2	0.7%	1.5%	2.1%

CALCULATED BY IWR, OCT 88, USING NAT'L GROWTH RATES ADAPTED FROM DRI, WEFA, USDA, DOE, FERT INST, IWR.

TABLE 2.3
U.S. INLAND WATERWAY TRAFFIC
HISTORIC TRAFFIC BY SEGMENT, SELECTED YEARS, 1965-1986
(MILLION SHORT TONS)

SELECTED WATERWAY SEGMENTS	1965	1970	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
UPPER MISSISSIPPI	37.8	54.0	63.1	68.3	67.0	68.8	68.5	76.3	74.5	74.7	84.1	81.8	72.0	73.7
MIDDLE MISSISSIPPI	41.5	58.3	71.5	78.0	74.3	79.2	80.3	92.8	92.2	90.5	98.7	103.6	92.7	97.7
MISSOURI R.	7.7	7.5	6.2	6.6	6.7	7.9	7.7	5.9	5.3	4.9	6.3	6.4	6.5	7.0
LOWER MISSISSIPPI	59.8	85.9	108.6	121.7	123.8	135.0	136.9	146.2	149.2	143.1	148.1	156.6	149.9	156.2
ARKANSAS R.	1.3	4.0	5.2	6.5	9.1	9.9	8.4	8.5	7.7	7.8	7.6	8.5	7.7	8.4
ILLINOIS WATERWAY	29.0	36.6	45.8	45.3	42.8	39.8	37.8	44.1	39.7	41.6	43.0	39.2	38.1	42.3
OHIO RIVER SYSTEM*	NA	NA	171.4	178.1	178.6	177.6	194.8	179.3	181.9	174.0	171.2	202.2	203.9	222.2
OHIO R. - MAINSTEM	103.2	129.5	140.1	148.4	151.4	152.6	165.3	155.9	158.7	150.7	150.4	174.7	177.5	195.6
MONONGAHELA R.	38.8	42.2	37.3	36.5	34.4	31.7	38.2	34.3	32.1	28.8	26.5	34.5	28.8	29.5
KANAWHA R.	13.2	14.0	12.5	12.3	10.8	11.0	13.8	14.7	13.0	13.7	13.2	14.2	14.6	16.8
CUMBERLAND R.	3.0	5.6	11.9	11.3	12.8	12.4	15.2	12.3	10.4	11.4	11.5	14.1	14.2	22.9
TENNESSEE R.	17.4	25.5	28.3	26.3	26.6	31.6	31.4	29.4	26.0	25.5	28.0	33.2	36.5	39.6
GULF INTRACOASTAL WW	78.5	100.1	96.4	98.6	104.3	101.4	96.6	94.1	89.9	81.9	83.8	92.4	101.3	105.7
BLK WARRIOR-TOMBIGBEE	7.8	11.1	12.8	14.7	15.3	14.6	15.3	16.7	16.0	15.2	14.7	19.6	18.9	17.9
ATLANTIC INTRACOASTAL	3.3	4.0	3.2	4.5	4.8	5.1	5.0	4.0	4.1	3.1	3.9	3.4	3.1	4.4
COLUMBIA R.	21.2	7.8	16.5	19.0	16.6	16.9	17.4	19.1	17.3	15.7	17.1	16.6	14.0	14.1
TOTAL	369.6	472.1	503.9	524.0	528.7	534.5	535.0	535.0	520.7	495.5	487.1	542.5	534.7	560.5

SOURCE: WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL

TABLE 2.4
U.S INTERNAL WATERWAY TRAFFIC PROJECTIONS
BY SEGMENT: LOW AND HIGH, 1990, 1995 AND 2000
(MILLIONS OF TONS)

SELECTED WATERWAY SEGMENTS	ACTUAL 1986	1990 LOW	1990 HIGH	1995 LOW	1995 HIGH	2000 LOW	2000 HIGH	GROWTH RATE LOW	GROWTH RATE HIGH
UPPER MISSISSIPPI	73.7	82.5	92.0	87.6	102.1	93.3	112.4	1.7%	3.1%
MIDDLE MISSISSIPPI	97.7	106.3	117.4	112.9	130.3	120.3	144.8	1.5%	2.9%
MISSOURI R.	7.0	6.8	7.6	6.5	8.5	6.2	9.4	-0.9%	2.1%
LOWER MISSISSIPPI	156.2	168.5	187.8	178.3	209.6	189.5	234.0	1.4%	2.9%
ARKANSAS R.	8.4	8.9	11.5	9.1	13.5	9.6	15.5	1.0%	4.5%
ILLINOIS WATERWAY	42.3	44.5	49.9	47.2	54.9	50.1	60.1	1.2%	2.5%
OHIO RIVER SYSTEM	222.2	232.3	254.2	248.2	288.1	266.8	327.0	1.3%	2.8%
OHIO R. - MAINSTEM	195.6	204.1	224.3	217.7	253.9	233.7	287.7	1.3%	2.8%
MONONGAHELA R.	29.5	38.5	42.1	40.5	48.6	43.1	56.2	2.7%	4.7%
KANAWHA R.*	16.8	18.1	21.4	19.5	24.6	21.2	28.4	1.7%	3.8%
CUMBERLAND R.*	14.2	15.7	18.0	16.2	20.8	17.0	23.7	1.2%	3.5%
TENNESSEE R.	39.6	41.3	44.4	44.0	50.1	47.1	56.6	1.2%	2.6%
GULF INTRACOASTAL WW	105.7	102.0	112.4	99.9	121.3	101.7	131.0	-0.3%	1.5%
BLK WARRIOR-TOMBIGBEE	17.9	22.1	24.1	23.6	26.9	25.3	30.2	2.5%	3.8%
ATLANTIC INTRACOASTAL	4.4	4.7	5.2	5.2	6.5	5.7	8.1	1.9%	4.5%
COLUMBIA R.	14.1	15.8	21.5	16.4	22.6	17.3	24.7	1.5%	4.1%
US TOTAL INTERNAL	560.5	572.7	622.3	591.6	681.6	620.1	748.2	0.7%	2.1%

* KANAWHA TOTAL SHOWN IS 1986 DATA FROM WCSC. OHIO RIVER DIVISION ESTIMATES ACTUAL TONNAGE AT 18.2 MILLION. CUMBERLAND TOTAL SHOWN IS 1985 DATA. PRELIM. 1987 DATA FROM WCSC SHOW 16.1 MILLION TONS.

PROJECTIONS CALCULATED BY CEWRC-IWR USING:

1) NATIONAL GROWTH RATES BY COMMODITY GROUP ADAPTED FROM DRI, WEFA, USDA, DOE, IWR.
WATERWAY SEGMENT PROJECTIONS BASED ON AN AVERAGE SHARE OF COMMODITY TRAFFIC FROM NATIONAL PROJECTIONS, WHICH VARIED BY WATERWAY DEPENDING ON HISTORIC PATTERNS AND COMMODITY GROUP. PROJECTIONS ARE PRELIMINARY AND SUBJECT TO REVISION.

2) LINEAR ADJUSTED PROJECTIONS CALCULATED BY ADDING THE DIFFERENCE (POSITIVE OR NEGATIVE) BETWEEN THE ORIGINAL BASE AND THE LINEAR ADJUSTED BASE TO EACH PROJECTED NUMBER. LINEAR ADJUSTED BASE IS 1986 CALCULATED VALUE USING LINEAR TREND ANALYSIS FOR 1965-1986 DATA BY WATERWAY AND FOR THE NATIONAL TOTAL. ONLY SELECTED WATERWAYS WERE CALCULATED BECAUSE OF A LACK OF DATA OR BECAUSE HISTORIC DATA EXHIBITED NO LINEAR RELATIONSHIP OVER TIME.

3) TREND PROJECTIONS BASED ON LINEAR REGRESSION ANALYSIS OF TIME SERIES TONNAGES FROM 1965-1986, AND ARE ONLY SHOWN FOR THOSE SEGMENTS WHICH DISPLAYED A LINEAR RELATIONSHIP OVER TIME.

4) FOR WATERWAYS WITH NONLINEAR HISTORIC DATA OR INCOMPLETE DATA, TWO STANDARD DEVIATIONS OF THE HISTORIC DATA WERE CALCULATED. THIS RANGE WAS THEN APPLIED TO MEAN VALUES OF THE HIGH AND LOW PROJECTIONS TO GENERATE NEW PROJECTIONS FOR THE YEAR 2000. INTERMEDIATE PROJECTIONS WERE THEN INTERPOLATED.

5) THESE WATERWAY PROJECTIONS ACCOUNT FOR THE MAXIMUM RANGE OF FORECASTS, LOW TO HIGH, CALCULATED BY USING ALL OF THE ABOVE TECHNIQUES.

FIGURE 2.1

U.S. INLAND WATERWAY TRAFFIC
PERCENT BY COMMODITY GROUP – 1986
TOTAL: 560 MILLION TONS

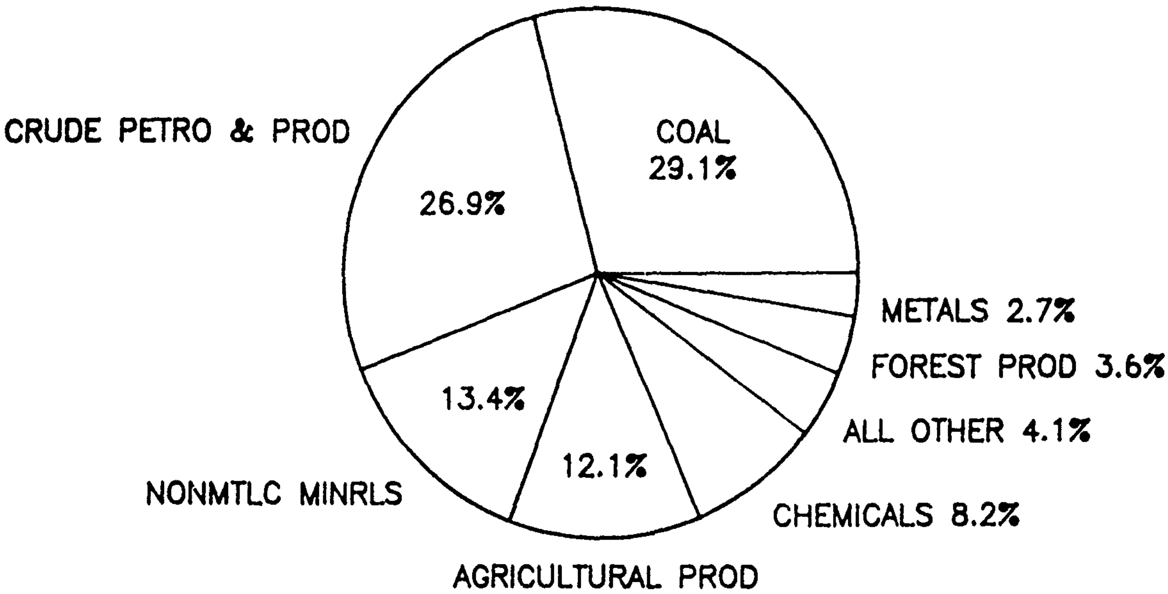
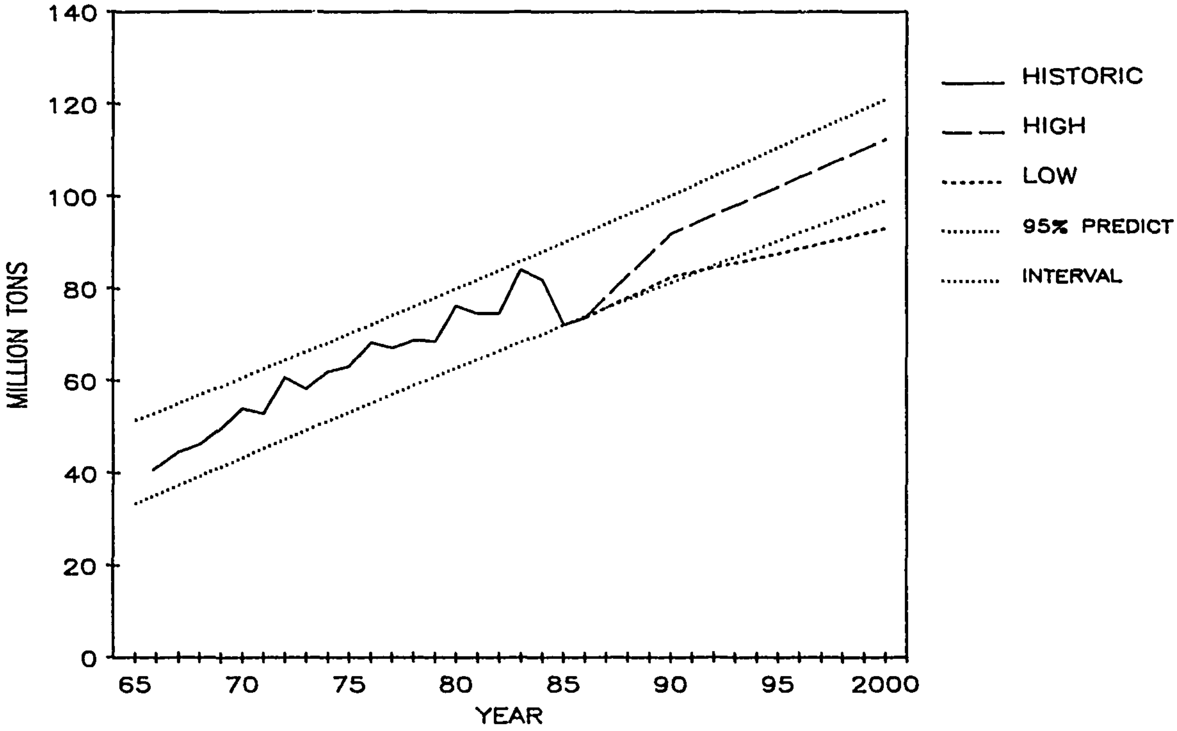
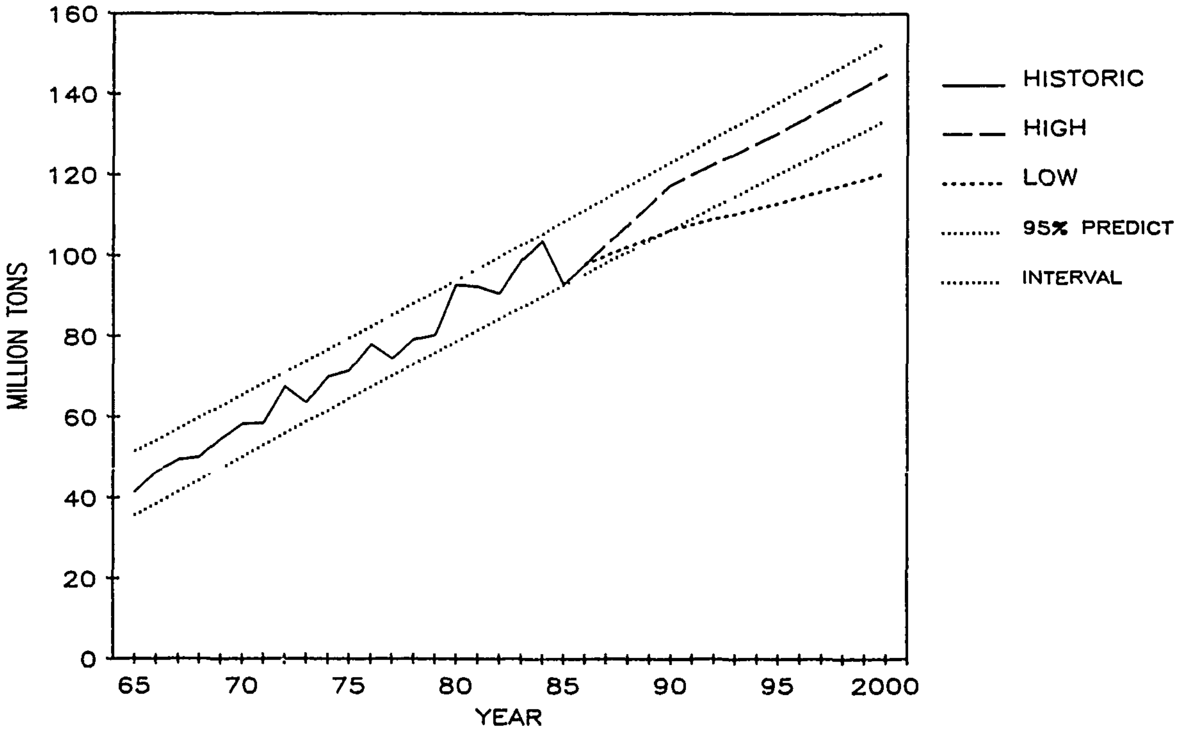


FIGURE 2.2
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.3
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.4
SEGMENT NUMBER 2
MISSOURI RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000

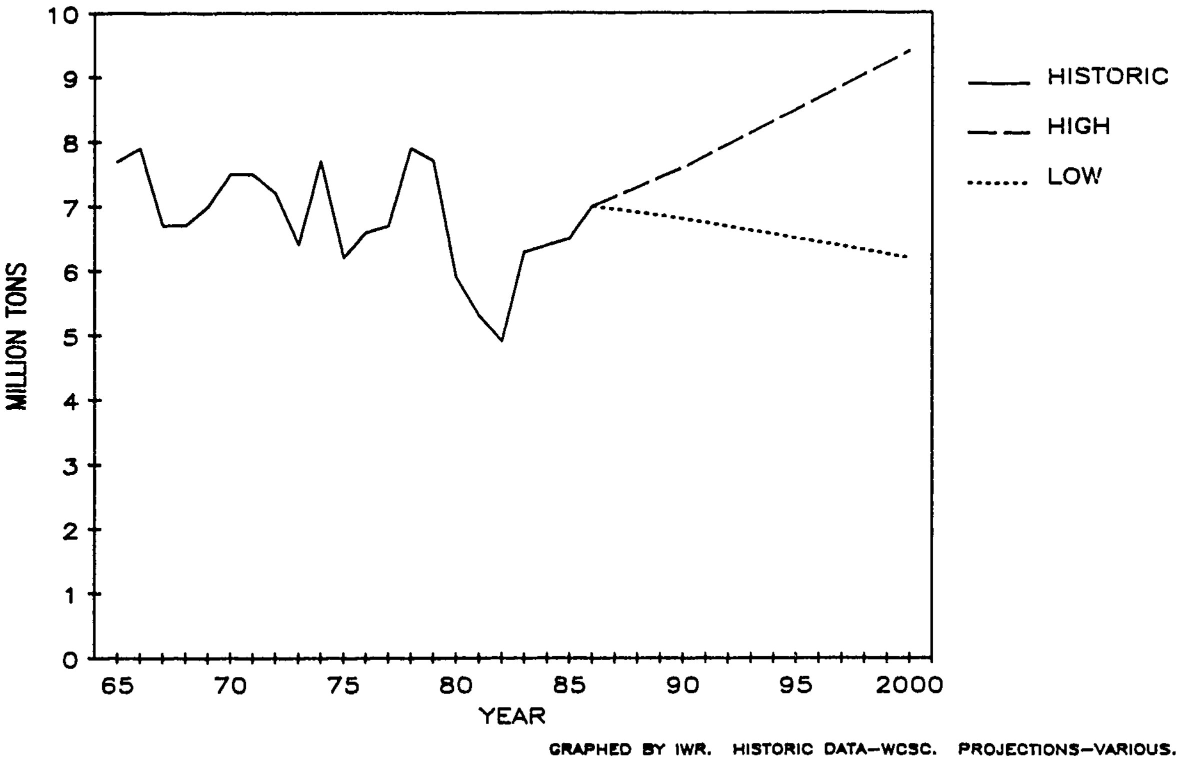


FIGURE 2.5
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000

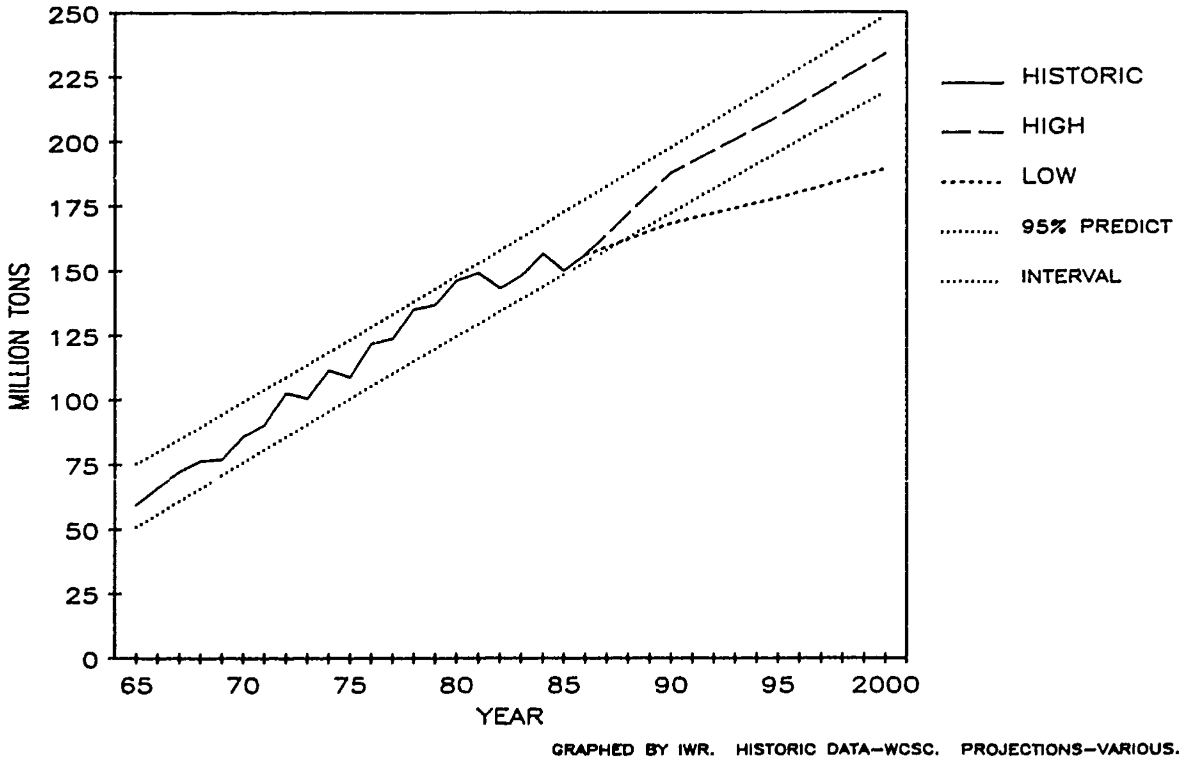


FIGURE 2.6
SEGMENT NUMBER 3
ARKANSAS RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000

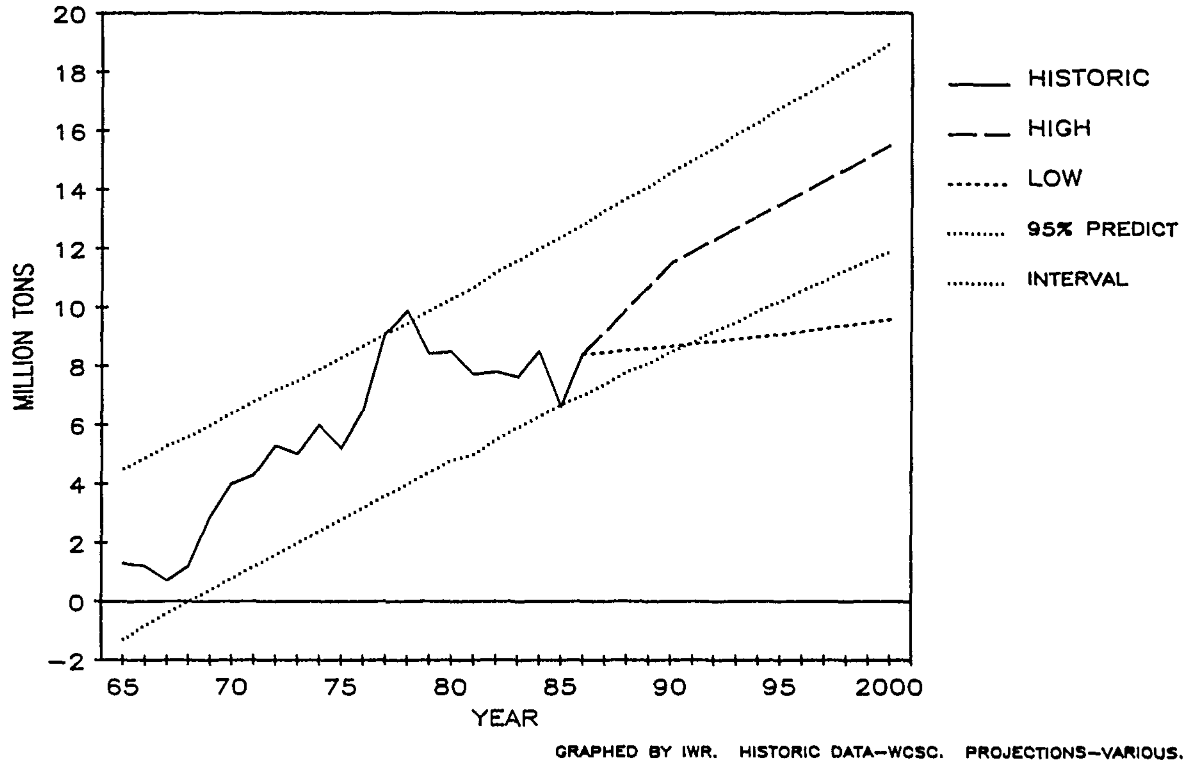


FIGURE 2.7
SEGMENT NUMBER 4
ILLINOIS WATERWAY TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000

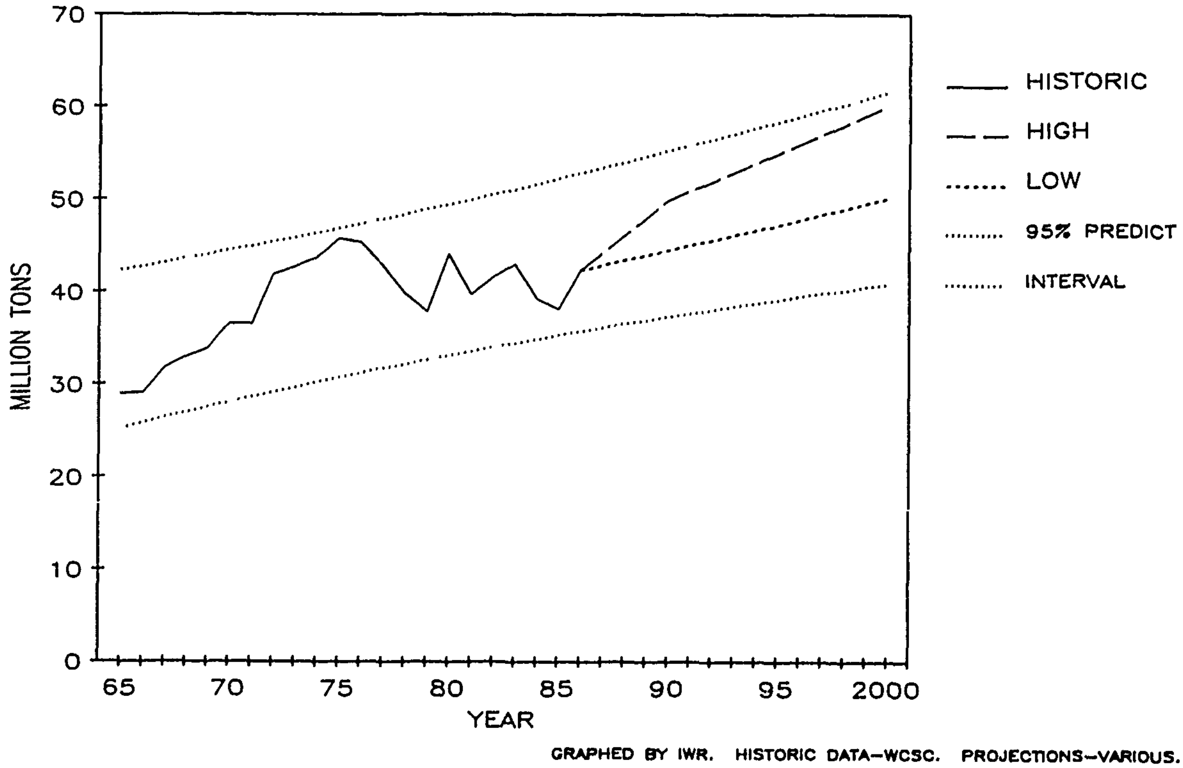
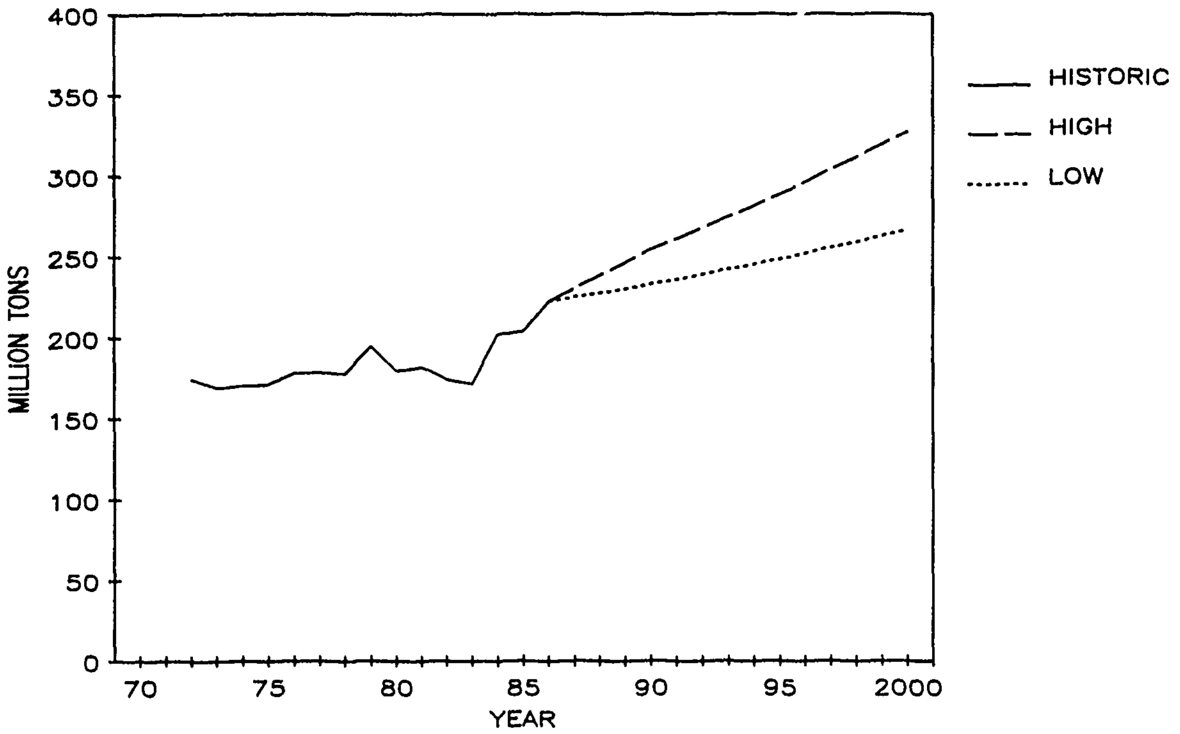
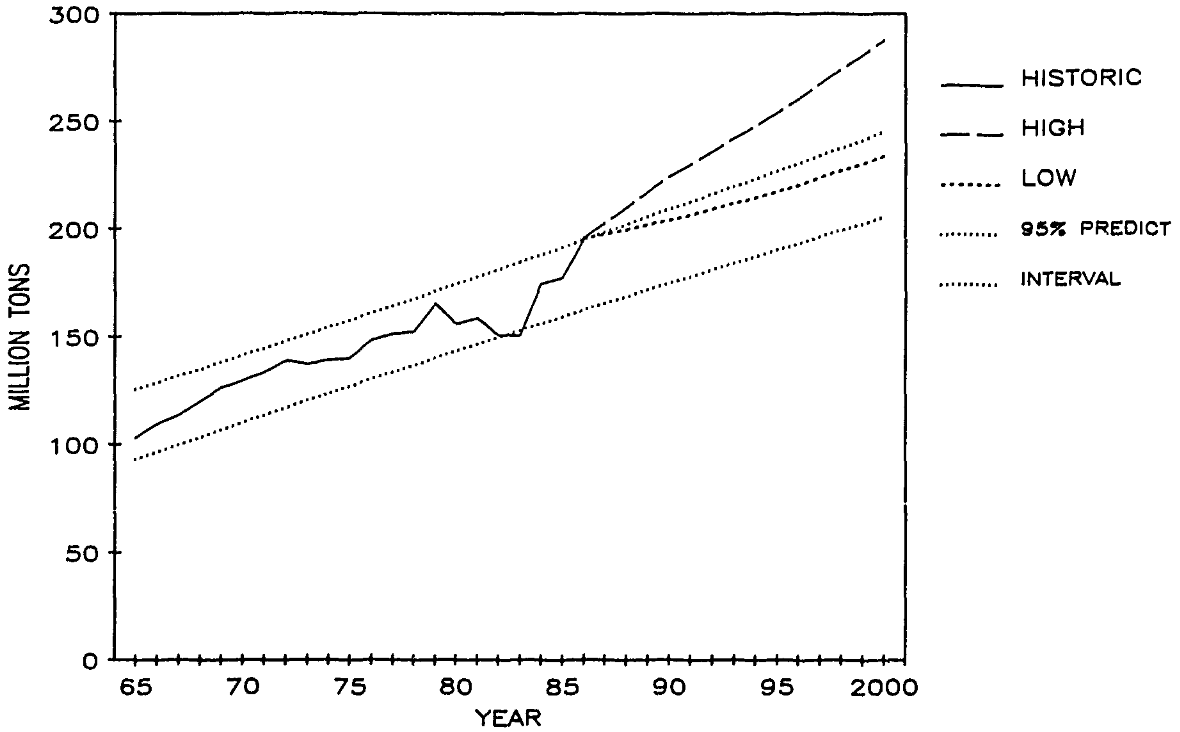


FIGURE 2.8
SEGMENT NUMBER 5
OHIO RIVER SYSTEM
HISTORIC 1972–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.9
SEGMENT NUMBER 5
OHIO RIVER–MAINSTEM TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



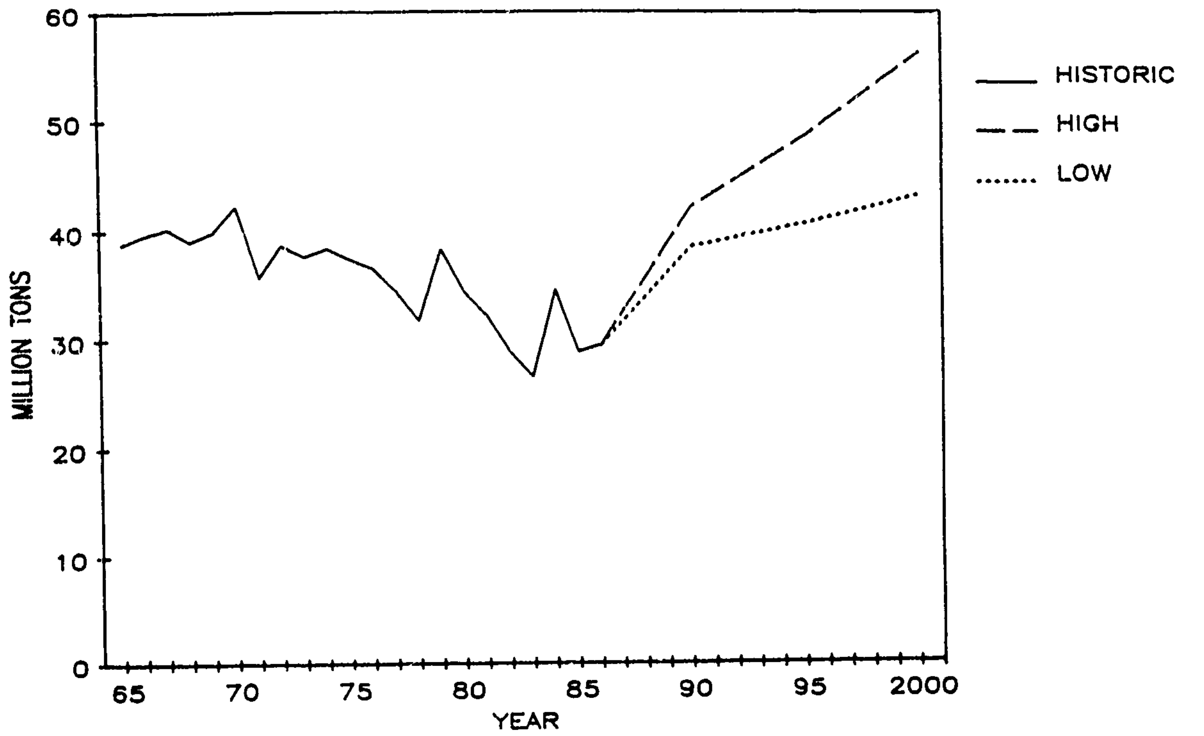
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.10

SEGMENT NUMBER 5

MONONGAHELA RIVER TRAFFIC

HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



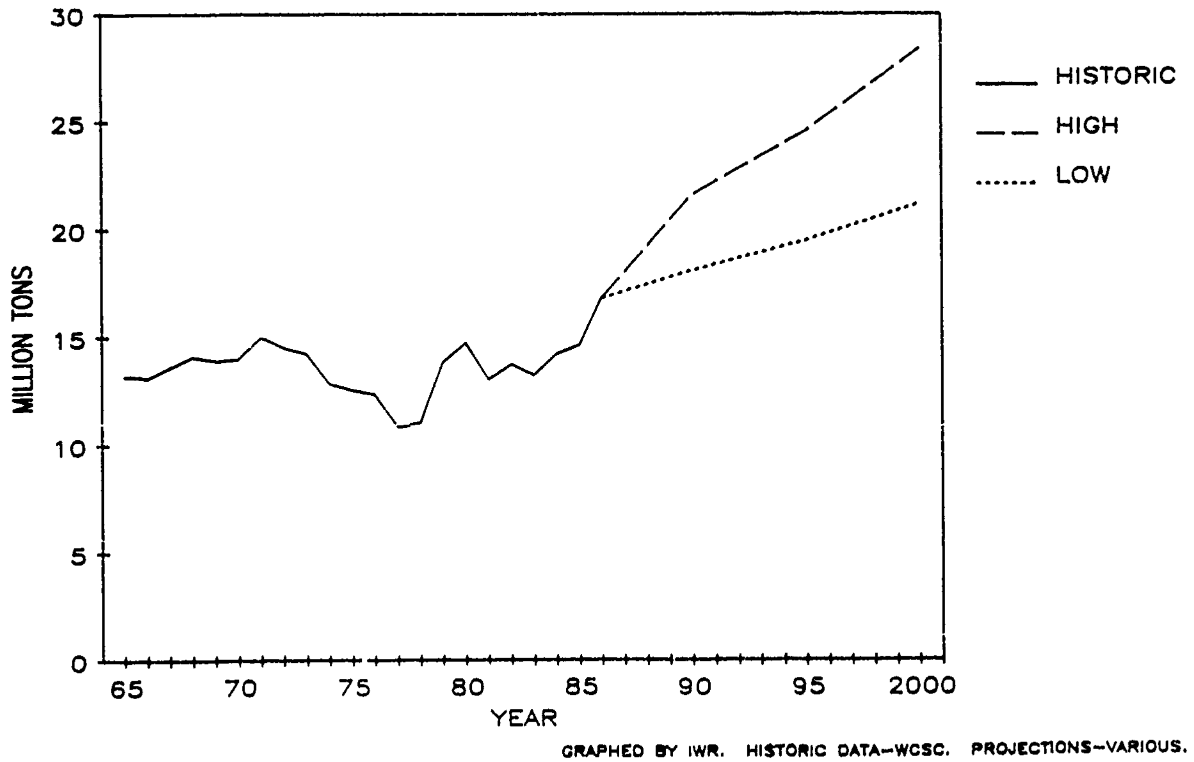
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.11

SEGMENT NUMBER 5

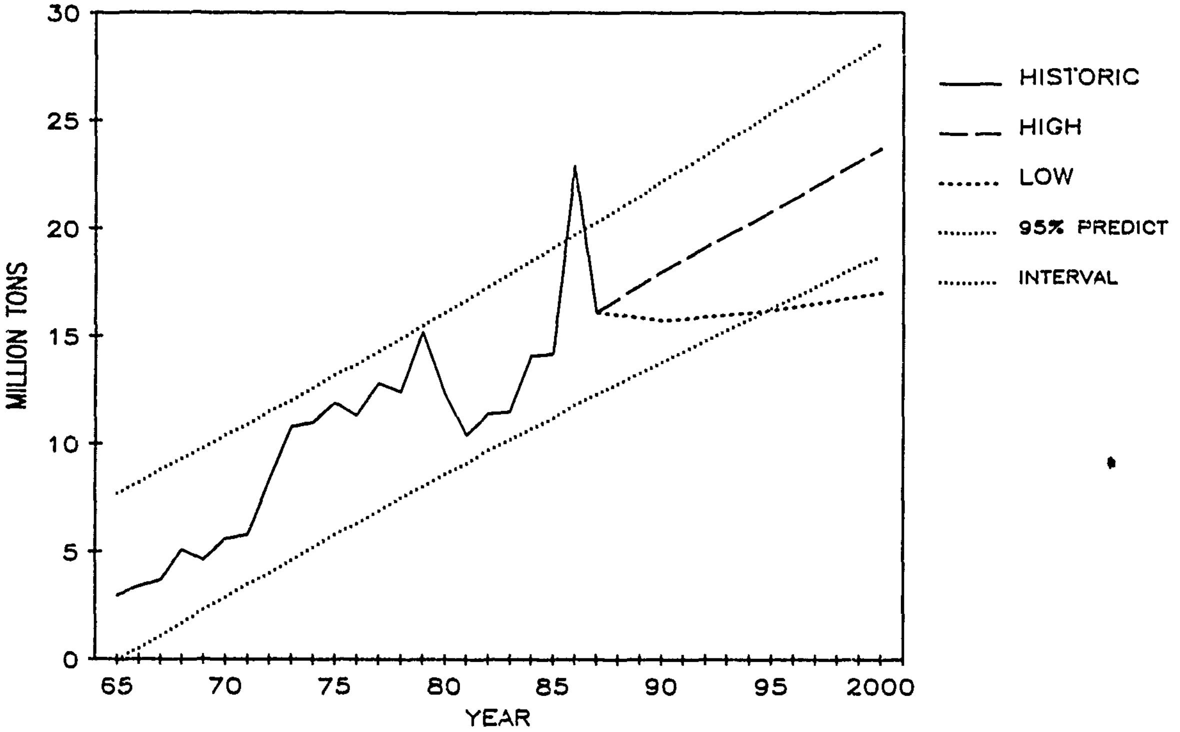
KANAWHA RIVER TRAFFIC

HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



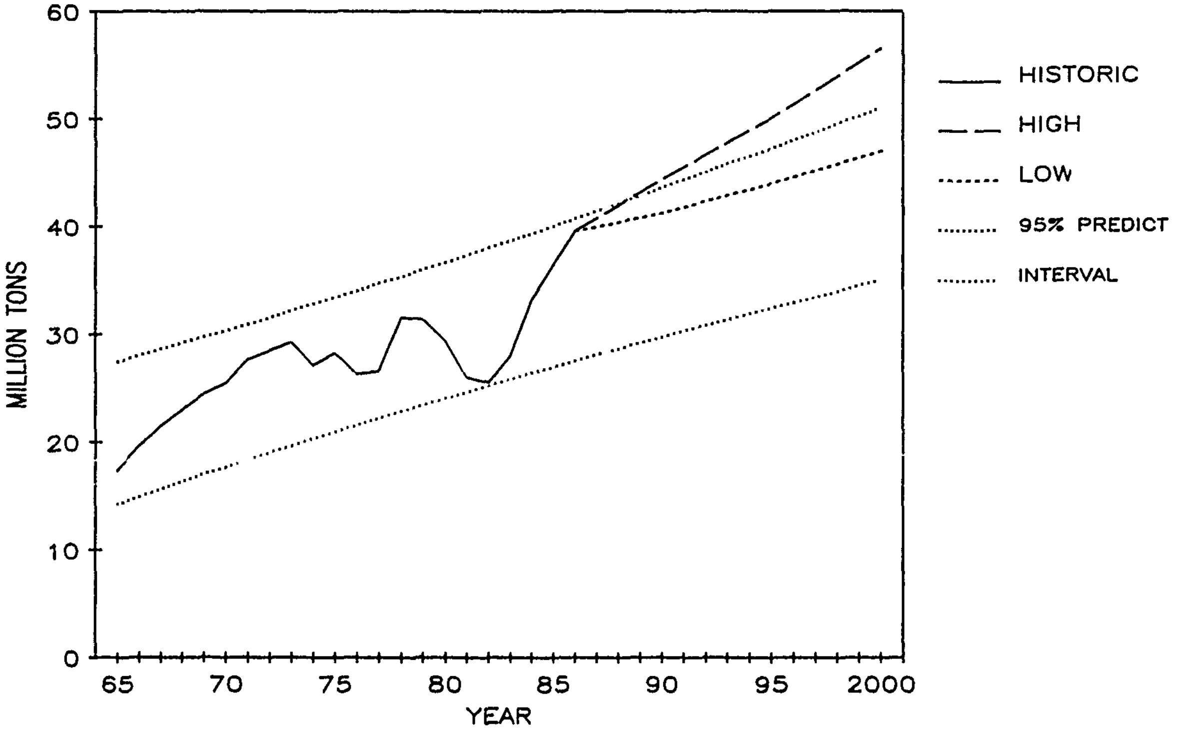
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.12
SEGMENT NUMBER 5
CUMBERLAND RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



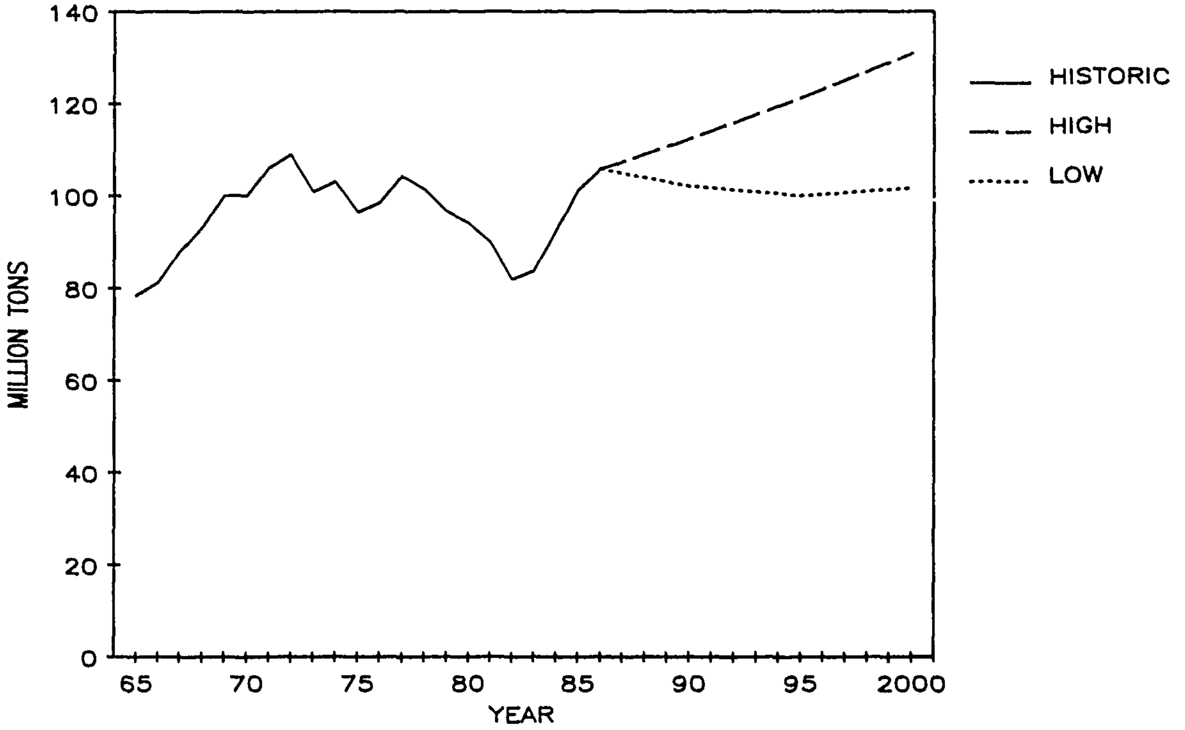
GRAPHED BY IWR. HISTORIC DATA–WCSC (87 DATA EST.). PROJECTIONS–VARIOUS.

FIGURE 2.13
SEGMENT NUMBER 5
TENNESSEE RIVER TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



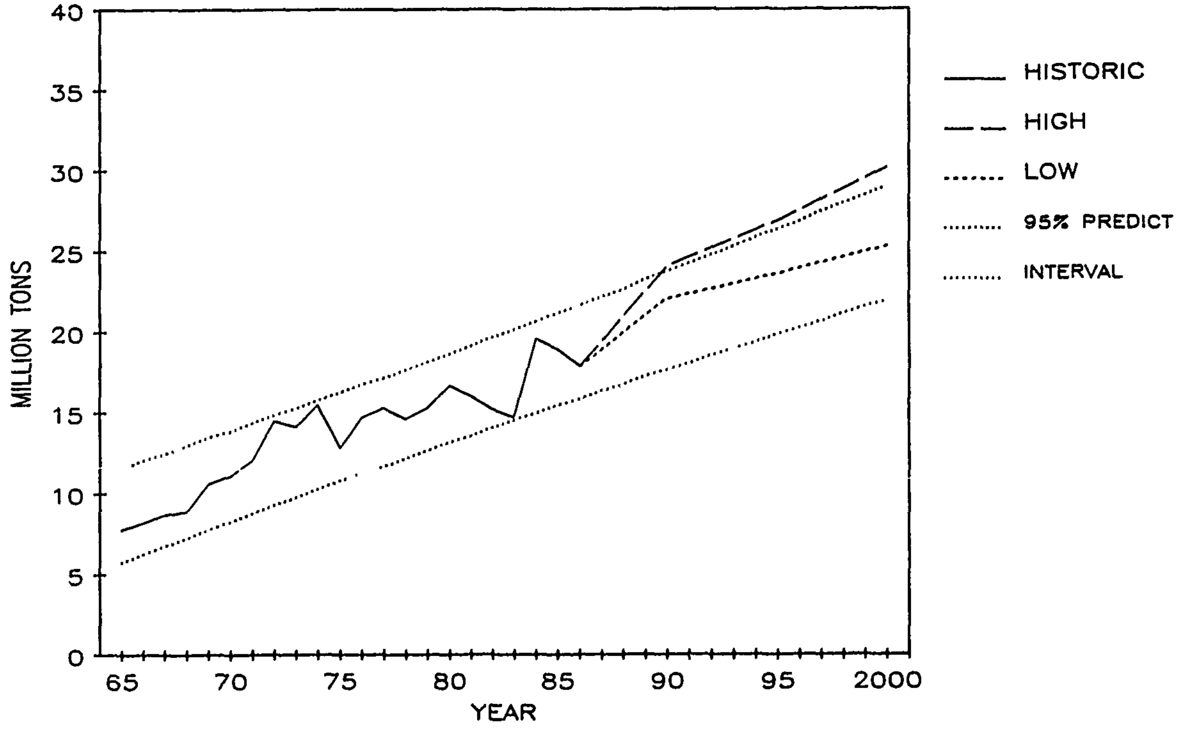
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.14
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



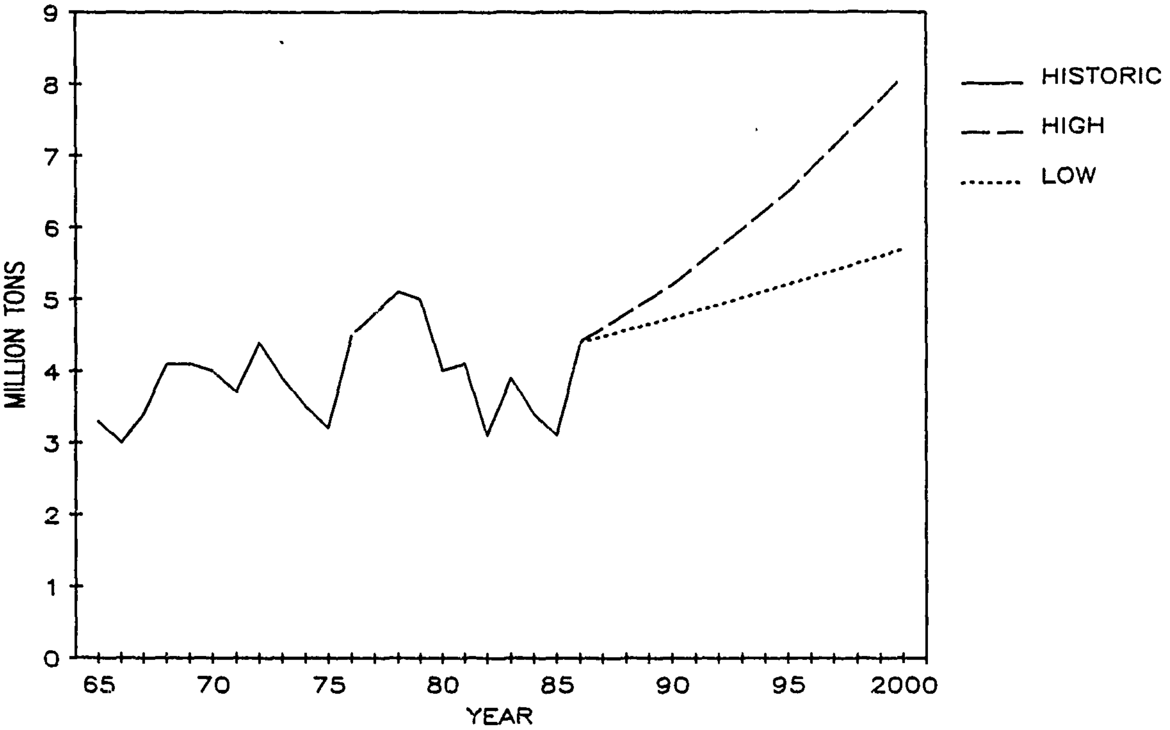
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.15
SEGMENT NUMBER 7
BLACK WARRIOR/TOMBIGBEE WW TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



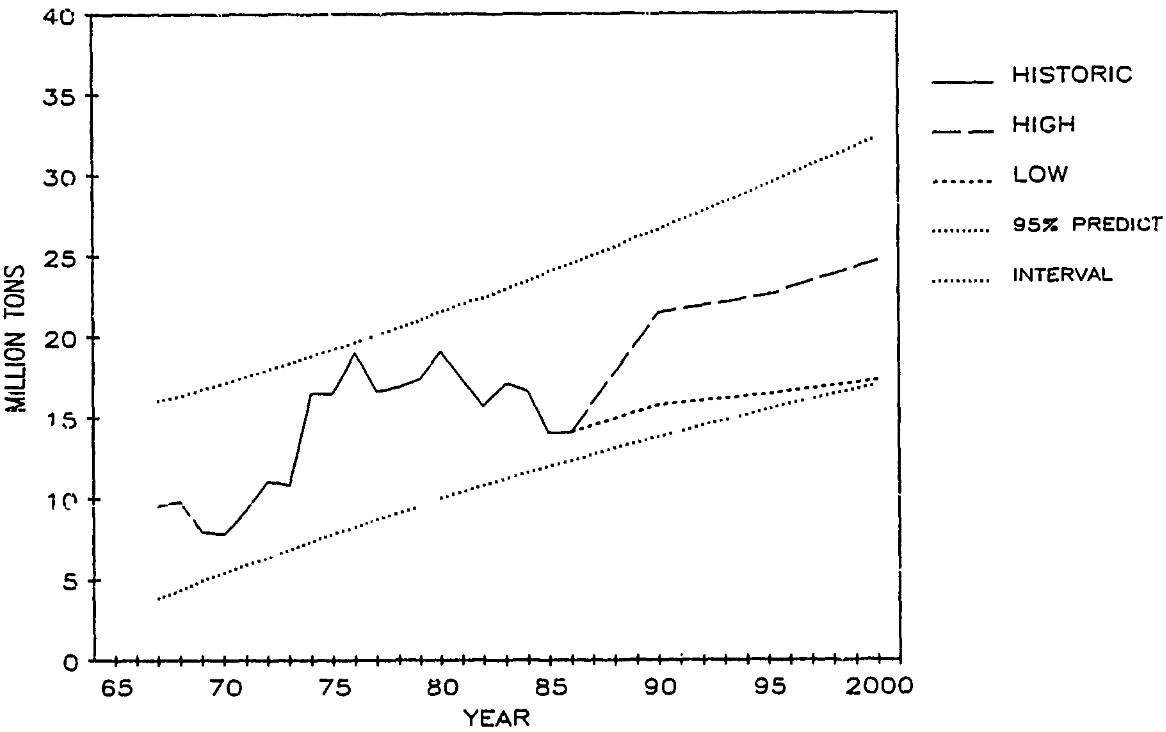
GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.16
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WW TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2(



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

FIGURE 2.17
SEGMENT NUMBER 9
COLUMBIA RIVER TRAFFIC
HISTORIC 1967–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA–WCSC. PROJECTIONS–VARIOUS.

Chapter 3

PERFORMANCE OF LOCKS

INTRODUCTION

The capability of a lock depends on many variables. Capacity is an estimate of the maximum number of tons of cargo of a specified mix that may transit a lock in a given period of time under normal operating conditions. The percentage of estimated capacity actually being used is shown in Appendix A for the locks on the various parts of the inland waterways system. The capacity estimates were reviewed by Corps districts in 1987; the difference between high and low estimates can be substantial, depending on assumptions about the level of future traffic, vessel operating practices, and lock operating conditions.

Age alone is not an adequate indicator of the condition of a lock, its problems, or its performance. For that reason the Corps maintains the Performance Monitoring System, to provide a number of performance indicators. This chapter uses some of those indicators and available data for the locks on the inland waterways system for the years 1980 through 1987, to present some basic relationships indicating the significance of problems of the system. In addition, 1987 PMS data for the waterways system is summarized.

THE PMS SYSTEM

The Performance Monitoring System (PMS) was established by the Corps in 1975, to collect and display data for over 250 lock chambers at some 190 locations. It provides a comprehensive record of the arrival and processing times for all vessels using the locks on the fuel-taxed system (216 chambers at 167 locations). Data collection is by lock operating personnel. The central data base is maintained by the Engineer Automation Support Activity (EASA), and is used to produce periodic summaries of lock statistics issued by the Water Resources Support Center. A large number of standard or special reports can be produced to identify lock performance, and the nature of the vessel traffic and commodities handled.

PMS is useful for monitoring the efficiency of individual lock operations, and also for comparing the performance of interacting locks to determine the problems and needs of the waterway system. The second use is the focus of the Review. There are numerous lock performance indicators that can be used for this purpose, such as wait time, processing time, and stall or downtime frequency and duration. An extreme value of one of these indicators is often evidence that a problem exists or may be developing. However, no one indicator is conclusive. Rankings of locks based on various indicators may have the same population of projects, but rarely the same rank order. Individual rankings may require qualification. For example, a high utilization rate implies a lock is approaching capacity, but it may be due to operating problems that can be cured without replacement. Accordingly, the purpose of this section is to examine performance indicators to identify the combination of indicators that give the most reliable indication of need.

PMS TERMINOLOGY

The PMS is a massive data base, with as many as 600 individuals involved in data collection. A lockage may produce up to 80 different items of information. To cope with this flow of information, many of the terms used in PMS are precisely defined in the PMS User Manual for Data Collection and Editing (Manual 85-UM-1, August 1985) and other PMS publications. Although the meaning of each term is generally self-evident, the use of the term may have very

narrow application by the individuals directly involved with PMS data. Additionally, many other terms are used in PMS publications without definitions, but they too have a precise meaning for the individuals involved. Finally, in order to examine and analyze PMS indicators herein, there was a need to redefine some terms, particularly when unique combinations of data are used. To facilitate a common understanding of the subsequent analyses, the following subsections describe the sources and uses of key terms more fully.

Terms specifically defined in PMS glossaries or instructions include:

Delay Time (same as Wait Time) - The time elapsed from the arrival of a tow or single vessel at a lock to the start of its approach to a lock chamber. Delay time for a queue of vessels or tows is the cumulative total for all vessels and tows waiting.

Lockage - The series of events required to transfer a vessel or tow (with all barges) through a lock in a single direction. More than one vessel can be processed during one lockage, and a tow may require several cycles to be completely processed.

Processing Time - Time to completely process a vessel through a lock, from start of lockage (SOL) to end of lockage (EOL). It is composed of lock processing time (dependent on lock operation) and vessel processing time (dependent on vessel operation).

Stall - An occurrence which stops lock operation (due to either a lock malfunction, weather conditions, a vessel problem, or seasonal or part-time lock operations). Stalls during idle time are still accounted for as stalls.

Transit Time - Time required for a vessel to transit a lock including waiting or delay time and processing time excluding stalls.

Terms used in PMS data entry or report forms but otherwise undefined include:

Lock Utilization Time/Rate - Utilization time is a derived number based on the total operating time (vessel and lock processing time and open pass operation) entered into the data base via individual lockage records. The utilization rate is the percentage produced by dividing total operating time by the total time in the reporting period (usually monthly).

Idle Time - This is the interval between lockages when the lock or chamber is available for service. It is a derived number produced by subtracting all stall time (including stall time that occurs when no vessels are awaiting lockage) and total operating or utilization time for the reporting period, from total chronological time in the period.

Available Time - This is the amount of time in a reporting period that a lock chamber is in service, operating and idle. This number is derived by subtracting all stall time from total chronological time.

Note: The PMS data accounts for all chronological time at a lock chamber with three basic catagories: utilization or operating time, idle time, and stall time. Stall time data is coded to identify the general and specific reason for interruption of service, and can be retrieved selectively based on those codes. Major subdivisions are: weather conditions, water or surface conditions, tow conditions, lock conditions, and other.

Terms used herein, including Appendix A, are explained in the following section. Briefly, their specific meanings for the purposes of this Review are as follows:

Delay Time - The combination of wait time plus stall time (as defined in PMS).

Processing Time - The combination of wait, stall, and processing time (as defined in PMS).

Downtime - Stall time (as defined by PMS).

Lock Utilization Time - Total chronological time less idle time.

RELEVANT LOCK PERFORMANCE INDICATORS

For the commercial waterway operator, time is literally money. Except for extraordinary circumstances such as low water, the time a tow spends underway in channels converts directly to ton-miles. The time spent at locks is expense, regardless of whether it is waiting, lock processing, or stall time. A generalized number for converting that time to expense is $700.00 per hour per tow. The time and related expense is a prime concern of the vessel operator. The purpose of the PMS statistics herein is to identify the components of that time and their interaction.

Because time is money, it has attraction as a device to identify priorities for improvements to the inland waterways system. Absent any other numbers, delay time and lock processing time can give some indication of the benefits foregone by delaying improvement projects. That could be an answer to the question raised by the Inland Waterways Users Board, but there are important caveats. Performance indicators have to be understood, interpreted and evaluated, and for that purpose the accompanying analysis is just a start. The definitive answer as to costs, benefits, or benefits foregone, is the lock-specific feasibility study. Consistent with those limitations, the focus of this section is to make PMS statistics as useful as possible.

Because of the large number of locks and individual indicators, it was desirable to combine related indicators to facilitate analysis and simplify the display of data in this Review and Appendix A. Therefore another caveat is necessary. Some of the numbers shown or used represent unique combinations of PMS data, and/or have been given unique names to distinguish their use herein. The point was to create a hierarchy of times that account for all of the time spent by a vessel or tow at a lock, in combinations most relevant for the vessel operator. A brief explanation of the data and terms used for that purpose is as follows:

Processing Time. This is a unique term as used herein, for a unique combination of lockage or lock processing time and a combination of wait and stall time called "delay time". It represents the total time spent by a vessel or tow at a lock, and is shown as average processing time for individual locks in Appendix A (Performance Characteristics, Table 2, Part A). This total accounts for vessel time, and has some usefulness in screening to identify problem locks. Inspection of its component parts is needed in order to identify the reasons for variation.

Lockage. This is defined as processing time in PMS manuals, and is shown as an average lock-specific time in Appendix A. It is an indicator of the technological obsolescence of a lock, in that older less efficient locks take longer for a hardware cycle than newer, more efficient locks. Extreme values may indicate lock dimensions are no longer adequate for current tow configurations. For any one lock this time is relatively constant because it depends on lock machinery and the number of cycles required to process the tows usually handled. Lock reliability is reflected in stall or downtime, and to focus on those factors lockage is not otherwise analyzed in this Review.

Delay Time. This is a unique term used herein for the combination of wait and stall time. Delay time is shown as both average time and total time in the lock-specific statistics in Appendix A. The relationship of delay time to lock utilization, stalls and stall time is analyzed later in this chapter. Wait time reflects queuing which depends on the level of traffic and lock capacity. Stall time represents interruptions due to lock and other conditions. Individually and collectively these times vary more than lockage time at any one lock. Collectively they can be considered non-productive time by the vessel operator. For that reason and economy of analysis, they are combined in the following analyses.

The average delay times shown in Appendix A are based on total delay hours divided by the total number of discreet vessels and tows processed at the various locks. An alternate measure of delay is to divide total delay only by the number of vessels and tows that actually experienced delay. In most cases the alternate calculation will produce a higher average delay. The average delay times shown are a combination of wait and stall time, and it was impractical to perform the alternate calculation to determine if this produced a significant difference.

Downtime. This is a unique term used herein for stall time. For display in Appendix A, its several causes or component parts have been consolidated into three categories: lock, natural, and tow and other conditions. The appendix shows both total hours and number of occurrences for lock-specific downtime or stalls (Table 2, Part B). Both measures are also used in the analyses that follow.

Utilization Rate. Similar to the total time spent by vessels at locks, there are performance indicators that collectively account for all the time of a lock. The utilization time defined in PMS accounts for operation or lockage time only. For the analyses in this Review a unique combination is used that accounts for stall time also, and gives an indication of residual capacity. Because this is a derived number, data entry errors can overstate utilization, particularly where multiple lock chambers or multiple lockages are involved. To minimize overstatement of utilization, the number was derived by subtracting idle time from total chronological time. In a few cases the unrealistic remainder was rounded down to 100 percent. The resulting utilization rates used in the following analyses are shown in Appendix A, Table 2, Part A.

The preceding combinations of PMS data demonstrate that many new and potentially useful combinations of data are possible. Also that an explicit description of the new combination is required because PMS has so many data elements and different users. Unless specifically stated otherwise in this and future Reviews, PMS data displayed or used will be in accordance with PMS definitions.

LOCK PERFORMANCE ANALYSES

The identification of problem locks with PMS is a preliminary to more useful analyses. Performance indicators can be used to determine the direction of Corps planning efforts, and ultimately that process can provide definitive analyses for investment decisions. In the interim, the indicators can provide a preliminary way to measure and predict the impact of the problem. That interim use is explored in the following analyses. It focuses on delay cost and its causes because they are a prime concern of waterway users. The following caveats should be noted:

First. Common wisdom is that wait time will increase exponentially as a lock approaches capacity. This notion is supported by data that indicate the relationship is lock specific and dependent on variable conditions. The point of the analyses is to identify the basic relationship, and for that purpose either an average lock or peak values are used. The relationships derived

from analyses are depicted as linear, although this is not true. The linearity is a simplifying assumption because the objective was to identify the relationship, not define it precisely. The precise curve will change as conditions change, and the effort required to determine the best fit with existing data wasn't justified. In brief, the relationship is shown as linear because that was the equation the computer was requested to produce.

Second. Lock utilization has been used as a proxy for lock capacity. Although the two measures are not identical, the utilization rate generally can be expected to correlate closely with the percentage of capacity used. Either measure has certain limitations. Lock capacity estimates are lock-specific and dependent on several assumed variables. Utilization rates reflect the actual mix of traffic, conditions, and other variables at a specific lock, hence the unutilized or idle time can be a good indication of residual capacity. However, the utilization rate as used herein does not distinguish between processing time and stall time. A high utilization rate may reflect high traffic levels or excessive downtime.

Delay and Lock Utilization. Figure 3.1 shows the average total annual delay time (all locks) and peak lock delay time for the years 1980 through 1987. (The peak lock was L&D 26 Upper Mississippi in 1980 and 1982, the Inner Harbor Lock at New Orleans all other years.) Because the peak locks account for a significant amount of total and average delay time, the delay-utilization relationship has been calculated two ways: based on the average of all locks, and based on the peak delays of all locks. A by-product of the first calculation is an indication of ambient or natural level of delay. The second calculation identifies the relationship at critical levels of utilization.

Figure 3.2 shows the relationship between delay time in thousands of hours per year and the percentage of lock utilization for the average lock for 1980-87. As expected, delay time increases as the percentage of utilization increases. The relationships shown are based on annual data from each lock in the PMS data base. The relationships represent an average for the entire system rather than the actual delay for any one lock. Specific locks with a given percentage of utilization may have more or less delay.

Figure 3.2 provides two specific pieces of useful information. First, an estimate of the actual delay time associated with a level of utilization can be obtained. For example, in 1986 a 60 percent utilization rate resulted in an average of 5,000 hours of delay. In 1984 there were 8,000 hours of delay with the same utilization rate. Second, the slope of the lines reveals how much delay increases for an increment increase in utilization. In 1980, every one percent increase in percentage of utilization resulted, on average, in a 72-hour increase in delays. For the years 1981 through 1987, respectively, a one percent increase in utilization resulted in average delay increases of 104, 36, 146, 134, 61, 47 and 324 hours. The extremely high rate for 1987 may reflect the fact that 1987 data are not yet complete. Errors may exist in the current 1987 data base.

Figure 3.2 also shows (neglecting 1987) that "natural" levels of delay at zero or low levels of lock utilization range from 0 to 2,500 hours per lock on average. At full utilization levels the range in delay is from about 5,500 hours to 13,000 hours per lock. In general, an individual lock that has more delay at a given percentage of utilization than the average is performing worse than a lock with less than average delay.

Figure 3.3 provides a single benchmark for summarizing system performance in terms of delay and utilization by isolating the peak year values shown in Figure 28. There are numerous options for summarizing the average lock performance through the 1980s. The relationship shown in Figure 3.3 is based on the delay observed during each lock's highest utilization

percentage in the 1980s. For example, the data entry for one lock may be from 1982, for another 1986, because they are the years over the period 1980 to 1987 during which utilization peaked at those particular locks. Figure 29 shows that a one percent increase in utilization for an average lock during the 1980s results in an additional 109 hours of delay per lock. A ten percent increase in utilization results in 1,090 hours of delay, etc. Comparing individual years to this 1980s average, 1983, 1984 and 1987 had higher levels of delay than other years.

To the extent that percentage of utilization reflects trends in percentage of capacity operation, we can see that the costs of delay can increase significantly as a lock approaches capacity operation. Using an assumed delay cost of $700 per hour for illustration purposes only, a one percent increase in utilization would on average cost about $75,000 per lock. A ten percent increase would cost $750,000. Over time these cumulative costs add up rapidly. It is worth recalling that these are average relationships and they could be much worse at problem locks.

Delay and Stalls. The causes of stalls have been grouped into three categories: lock conditions, natural conditions, and other conditions. Lock condition stalls occur because of equipment malfunction, testing and maintenance, debris in the chamber, or unavailable lock personnel. The frequency and duration of these types of stalls are, in theory, correctable. Rehabilitation or replacement of a lock with much lock-related downtime would presumably result in less equipment malfunction and less need for testing and maintenance.

Natural condition stalls include weather and water surface conditions. These stalls, for the most part cannot be affected by waterway reinvestment. There are, however, cases where an improved approach wall alignment or other structural change could mitigate the effect of some natural conditions. Other conditions that can cause stalls include tow malfunction or interference, collisions or accidents, and other unspecified causes. These causes are also, in general, less subject to control through policy choices.

Lock performance can be affected by two dimensions of the downtime problem. First, the frequency with which a lock is out of service is important to users. To measure this dimension we use the number of stall events regardless of their duration. The second dimension is the duration of a stall. Very long stalls allow shippers the option of shipping by other modes if the stall is anticipated, such as scheduled maintenance, or its duration can be reasonably forecast, such as a flood or ice jam. Very short duration stalls may be little more than a nuisance. At present we use the total downtime per year as a measure of the duration of stall events.

Figure 3.4 shows the relationship between delay time in tens of thousands of hours and the number of stalls for an average lock. All years show that delay time increases with the number of stalls. Because most stall occurrences are subject to chance it is reasonable to expect that vessel trip time will likewise be affected. If stall occurrences were perfectly known schedules could be adjusted to eliminate or at least minimize their effects. Because they are not known, substantial effects can be observed.

"Natural" levels of delay observed with no stalls are consistent with those shown in the section above through the 1980s. At a level of 400 stalls per year (again neglecting 1987) delay ranges from 36,000 to 57,000 hours on average. Few locks have experienced such large numbers of delays and this figure is more relevant in the range of stalls from 0 to 100.

The slopes of the lines again provide some useful information. In 1980 one additional stall event caused 119 hours of additional delay on average. Delays for the years 1981 through 1987

for one more stall caused additional delay of 99, 109, 146, 105, 91, 110, and 22 hours, respectively.

Figure 3.5 shows the relationship between the number of stalls and delay time for the peak years of each lock as described in the previous section. This 1980's average indicates that one more stall caused an additional 111 hours of delay time on average. Compared to this average, 1980 and 1982 were worse than average years for delays related to the number of stalls.

Figure 3.6 shows the relationship between the duration of stalls, measured as the number of hours the lock is closed per year, and delay during the 1980s. From 1980 through 1984 delay decreases as the duration of stall times increases. From 1985 through 1987 delay time increases with the duration of stalls. Not much can be made of these results unless a more detailed analysis is undertaken to discover the specific reasons for the downtime.

Figure 3.7 shows the peak year relationship between duration of stall and delay. In this case one more hour of stall time resulted in an additional 11 hours of delay.

In summary, this analysis shows that the frequency of stall occurrences contributes more to delay than does the duration of the stall. Based on the preceding analysis, a one percent reduction in lock utilization or downtime will save about 109 hours of delay time. Improvement in lock reliability (i.e. fewer and shorter stalls) effected through rehabilitation and maintenance programs, can reduce delay time significantly; 111 hours per stall event and 11 hours per stall hour, based on the 1980's data. These estimates are for average situations. It must be kept in mind that specific locks may have circumstances significantly different from the average.

1987 LOCK PERFORMANCE

The preceding analyses demonstrate some uses of performance indicators. This section presents a summary of 1987 PMS data. The data for locks on the fuel-taxed waterway system are shown in Appendix A (Performance Characteristics, Table 2, Parts A and B) and include peak year values of key indicators in the 1980-87 period for individual locks. A consolidated listing of the locks showing certain key 1987 indicators is presented in Table 3.1. The indicators shown on that listing have been used to produce rankings of the locks based on average delay time, average processing time, total delay time, total downtime, total stall events, and utilization percentage, that are shown in Tables 3-8 in the Review Overview.

Table 3.1 shows 1987 data not available (N.A.) for many locks. In almost all cases, the problem is data were incomplete. Complete data were available for 112 locks. In most years, (1980-86) complete data were available for about 165 locks. Because of the missing data, the figures in this section are labeled "for selected locks". The rankings of locks based on key indicators are presented in the Overview in order to identify "problem locks" and provide a reference for the discussion of the Corps waterways improvement program.

The following summaries are related to key performance indicators. They are supplemented with figures showing the distribution of indicator values. As noted in the preceding analysis section, certain "problem" locks with extreme values have a significant effect on the averages. Accordingly, most distributions are shown twice; with and without the extreme value locks.

Delay Time. For the 112 locks for which 1987 data are available, the mean of all average delays is 73 minutes, the median average delay is 27. Eighty percent of the locks have average delays less than 120 minutes. Figures 3.8 and 3.9 show the distribution of average delay times

for 1987. Figure 3.8 shows the delay for all available locks while Figure 3.9 shows the distribution for locks with delays less than 200 minutes in greater detail.

Average total delay for all locks in 1987 was 5636.70 hours. The median total delay was much less at 1,349 hours. Figures 3.10 and 3.11 show the distribution of total delays for all locks, and those with delays less than 10,000 hours, respectively.

Processing Time. Average processing time for all the locks in 1987 was 134.24 minutes, the median was 90 minutes. Eighty percent of all lockages were processed in less than 200 minutes. Figures 3.12 and 3.13 show distributions of average processing time for all locks and for locks with average processing times less than 400 minutes. Average processing time, displays a high correlation with average delay time as expected. Lock and Dam 20 on the Mississippi River is the lock with the longest processing time for locks on major waterways. Major rehabilitation was initiated at L&D 20 in 1986.

Downtime. Average downtime for all locks was 323.67 hours. Median downtime was 65 hours. Fourteen locks had no downtime, almost seventy-five percent had less than 240 hours. The extremely high downtimes for the top 16 locks creates a high mean. In fact, almost half the locks had less than 60 hours of delay. Figures 3.14 and 3.15 show the distribution of downtime for all locks, and for locks with less than 2,000 hours of downtime, respectively. Montgomery Lock and Dam, with the peak 1989 downtime of 6652 hours, was out of service for about 75 percent of the year.

The average number of stall events per lock was 70.79 in 1987. The median was 20 events. Seventy-five percent had 70 or less events. Figures 3.16 and 3.17 show the distribution of stall events for all locks and for those with less than 100 events.

The correlation between total downtime and the number of stall events, shown in Table 3.1, is not as great as one might expect. Montgomery and Port Allen, numbers 1 and 3 in total downtime, are numbers 17 and 18 in the number of stalls. Lockport with 860 stalls in 1987, is 22nd in total downtime. The simple explanation for this is that locks with the most downtime tended to have stalls of longer than average duration. Montgomery, for example, had stalls with an average duration of nearly 47 hours while Lockport stalls lasted an average of about 15 minutes.

Utilization rate. The 1987 average utilization rate was 39 percent. The median was slightly higher at 43 percent. About 70 percent of all locks had utilization rates of 50 or below. Figure 3.8 shows the distribution of utilization rates. Inner Harbor Lock on the Gulf Intracoastal Waterway is essentially fully utilized. A utilization rate of 100 percent or greater is a logical impossibility however, and reflects a data error.

RECREATIONAL USE OF LOCKS

Recreational use of waterways is generally compatible with commercial navigation. Any competition in use is likely to be at locks when queuing occurs. Because the recreation craft are fragile compared to commercial vessels, separate lockages are often required, and there are in effect two queues. Because of the growing number of recreational craft and their increasing use for cruising instead of sedentary fishing, the competition at locks is expected to increase. Historically, the question of priority of use has been handled to the satisfaction of both parties by the good judgement of the lockmaster. One solution has been to give priority to a recreational lockage after three priority commercial lockages. There is a perceived need for

more concrete solutions to the potential or actual problem. The immediate problem is the need for a good way to predict and measure the impact of recreational use of locks.

Table 3.2 shows the extent of recreational usage of locks for selected locks in 1986. Utilization rates are presented to put overall usage in proper context. One measure presented is recreational lockages (lockages containing only recreational vessels) as a percent of total lockages in the third quarter of 1986. The measure is based only on July, August and September waterway traffic because recreational traffic tends to be seasonal. A year-round measure disguises the magnitude of the problem at specific locks. A second measure is the recreational utilization rate obtained by multiplying the utilization rate by the percent of recreational lockages. This is done for the main chamber on'y. Because recreational craft can enter and exit locks much more repidly than commercial vessels, this utilization rate may overstate actual impact significantly.

Recreational lockages as a percent of all lockages are often very high for the auxiliary chamber and low for the main chamber as is the case for many Ohio River locks. In such cases serious congestion problems could result if the services of the auxiliary chamber are lost for any period of time.

The percent of recreational lockages can also be misleading. For example, Watts Bar on the Tennessee River, where recreation comprises 60 percent of all lockages, a potential problem for commercial navigation. When the low utilization rate of 17 percent is taken into account, however, it is apparent that the lock is relatively underutilized and it is no longer obvious that recreation presents a problem to commercial navigation.

The recreation utilization rate combines the information in the first two columns of Table 3.2 into a measure that more fully characterizes the potential problem presented by recreation traffic. By this measure, the heaviest recreation use relative to overall traffic levels is on the Upper Mississippi, the Illinois and the Tennessee Rivers.

About half of all lockages on the Upper Mississippi River above Lock and Dam 13 are recreational. Likewise, locks on the Lower Mississippi and Arkansas Rivers have usage greater than 50 percent. On the Ohio River the vast majority of traffic through the auxiliary locks is recreational. The Tennessee river has substantial amounts of recreational traffic.

Further study to better understand the problems presented by recreational usage of the inland waterway locks and dams is warranted.

TABLE 3.1

PERFORMANCE MONITORING SYSTEM - SELECTED INDICATORS

1987 PMS DATA FOR WATERWAY SYSTEM LOCKS

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

SEGMENT NUMBER & NAME LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
#1 UPPER MISSISSIPPI							
U St Anthy Fls(Miss)	2	25	25	8	22	15	0.8
L St Anthy Fls(Miss)	4	33	82	16	39	20	1.3
No. 1 (Upper Miss) (2)	2	35	49	3	2	62	1.3
No. 2 (Upper Miss)	39	106	802	28	5	41	10.4
No. 3 (Upper Miss) (2)	27	95	609	13	4	41	10.5
No. 4 (Upper Miss)	24	94	540	2	1	44	11.0
No. 5 (Upper Miss)	24	94	545	0	0	43	11.0
No. 5a (Upper Miss) (2)	19	82	417	3	2	42	11.2
No. 6 (Upper Miss) (2)	28	102	647	1	1	45	12.6
No. 7 (Upper Miss) (2)	31	102	722	4	3	47	12.6
No. 8 (Upper Miss) (2)	32	109	719	3	3	45	13.1
No. 9 (Upper Miss) (2)	31	111	695	13	3	44	14.0
No. 10 (Upper Miss)	29	93	855	0	0	43	15.5
No. 11 (Upper Miss)	49	122	1516	30	5	49	15.8
No. 12 (Upper Miss)	60	123	2519	19	39	46	19.3
No. 13 (Upper Miss)	79	138	3491	49	14	45	19.4
No. 14 (Upper Miss) (2)	78	146	3969	79	35	60	24.4
No. 15 (Upper Miss)	121	188	8288	389	554	46	25.2
No. 16 (Upper Miss	216	294	11256	158	63	53	27.2
No. 17 (Upper Miss)	334	420	15981	62	17	58	29.2
No. 18 (Upper Miss)	111	193	5385	513	79	52	29.8
No. 19 (Upper Miss) (2)	45	107	2226	146	72	43	31.2
No. 20 (Upper Miss) (2)	867	961	46030	244	148	76	31.9
No. 21 (Upper Miss) (2)	135	218	7264	692	42	52	33.4
No. 22 (Upper Miss) (2)	204	300	11132	105	28	64	34.2
No. 24 (Upper Miss)	246	335	13328	62	210	63	35.3
No. 25 (Upper Miss)	231	315	12285	141	78	61	35.3
L&D 26 (Upper Miss) (1)	465	552	56165	377	562	97	69.3
#2 MIDDLE MISSISSIPPI							
L&D 27 (Upper Miss)	49	88	9125	246	85	62	78.0
Kaskaskia	58	83	289	1558	6	11	3.1
#3 LOWER MISSISSIPPI							
Norrell (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2 (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3 (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 4 (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 5 (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
David Terry (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Murray (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 3.1 continued

PERFORMANCE MONITORING SYSTEM - SELECTED INDICATORS

1987 PMS DATA FOR WATERWAY SYSTEM LOCKS

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

SEGMENT NUMBER & NAME LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
#3 continued							
Toad Suck (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Ormond (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dardanelle (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Ozark (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 13 (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
W. D. Mayo (Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Robert S. Kerr(Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Webbers Falls(Ark)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Chouteau (Verd.R.)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Newt Graham(Verd.R.)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Jonesville(Ouachita)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Columbia (Ouachita)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Felsenthal(Ouachita)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
H K Thatcher (Ouachita)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 1 (Red)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Overton (Red)(U/C)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3 (Red)(U/C)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Old River(Atchaflya)	27	63	1349	179	53	28	8.0
#4 ILLINOIS WATERWAY							
LaGrange (Ill) (2)	295	371	15384	230	119	54	30.3
Peoria (Ill) (2)	125	188	6947	155	108	49	26.4
Starved Rock (Ill) (2)	44	111	2116	31	58	45	19.3
Marseilles (Ill) (2)	75	157	3527	88	156	52	17.6
Dresden Island (Ill) (2)	44	112	2170	39	35	46	16.7
Brandon Road (Ill) (2)	56	121	3250	123	114	48	14.4
Lockport (Ill) (2)	127	198	7259	336	860	52	13.9
T.J. O'Brien (Ill)	4	38	173	6	6	34	6.8
#5 OHIO RIVER SYSTEM							
Emsworth (Ohio) (2)(3)	25	80	1730	118	14	63	20.4
Dashields (Ohio) (2)(3)	30	91	1965	74	20	57	21.7
Montgomery (Ohio) (2)(3)	104	157	7383	6652	142	N.A.	23.0
New Cumberland(Ohio)	12	68	634	31	9	50	28.2
Pike Island (Ohio)	11	61	621	221	11	44	34.0
Hannibal (Ohio)	12	65	605	769	57	33	N.A.
Willow Island (Ohio)	10	60	3540	65	6	0	28.7
Belleville (Ohio)	9	61	467	8	6	19	30.6
Racine (Ohio)	18	71	1631	1008	41	17	31.6
Gallipolis (Ohio) (1)	291	392	20608	1141	200	43	34.5
Greenup (Ohio)	19	67	1469	0	0	25	42.1

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 3.1 continued

PERFORMANCE MONITORING SYSTEM - SELECTED INDICATORS

1987 PMS DATA FOR WATERWAY SYSTEM LOCKS

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

SEGMENT NUMBER & NAME LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
#5 continued							
Meldahl (Ohio)	200	269	14387	3235	63	45	46.3
Markland (Ohio)	32	87	2509	552	50	21	53.9
McAlpine (Ohio) (3)	296	356	26186	287	119	65	55.9
Cannelton (Ohio)	56	113	4914	59	54	32	61.0
Newburgh (Ohio)	24	71	2740	59	230	36	69.7
Uniontown (Ohio)	31	76	3528	178	52	34	77.6
Smithland (Ohio)	6	55	791	328	137	37	87.2
L&D 52 (Ohio) (1)(2)	169	216	27523	1834	185	59	N.A.
L&D 53 (Ohio) (1)(2)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2 (Mon) (3)	15	59	1065	981	12	53	17.7
L&D 3 (Mon) (2)(3)	16	50	1675	51	3	59	19.9
L&D 4 (Mon) (3)	22	69	1720	55	7	55	17.7
Maxwell (Mon)	2	37	249	1301	9	53	16.3
L&D 7 (Mon) (1)	39	92	3317	48	17	59	14.3
L&D 8 (Mon) (1)	21	69	1553	60	4	48	12.2
Morgantown (Mon)	2	29	41	10	5	10	3.2
Hildebrand (Mon)	1	33	6	0	0	5	1.7
Opekiska (Mon)	2	29	10	0	0	4	0.7
L&D 2 (Allegheny)	9	33	256	146	7	26	2.6
L&D 3 (Allegheny)	8	36	255	9	3	23	2.6
L&D 4 (Allegheny)	3	28	73	0	0	17	1.5
L&D 5 (Allegheny)	1	24	14	99	3	8	0.7
L&D 6 (Allegheny)	1	23	6	0	0	4	N.A.
L&D 7 (Allegheny)	1	20	2	0	0	5	N.A.
L&D 8 (Allegheny)	0	20	0	143	4	3	N.A.
L&D 9 (Allegheny)	0	19	0	0	0	3	N.A.
Winfield (Kanawha) (1)	244	416	13066	785	187	81	17.3
Marmet (Kanawha) (3)	35	183	3300	96	18	48	10.1
London (Kanawha)	39	140	2267	1039	344	21	3.9
L&D 1 (Kentucky)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2 (Kentucky)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3 (Kentucky)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 1 (Green)	3	24	157	14	7	14	10.1
L&D 2 (Green)	2	28	82	0	0	13	6.3
Barkley (Cumberland)	15	75	341	64	41	21	5.0
Cheatham(Cumberland)	11	62	213	73	46	12	4.9
Old Hickory(Cmbrlnd)	9	60	88	36	10	18	0.8
CordellHull(Cmbrlnd)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Kentucky (Tenn) (3)	247	356	15786	194	280	86	30.1

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 3.1 continued

PERFORMANCE MONITORING SYSTEM - SELECTED INDICATORS

1987 PMS DATA FOR WATERWAY SYSTEM LOCKS

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

LOCK NAME & (RIVER)	TIME (MIN)	TIME (MIN)	TIME (HRS)	TIME (HRS)	EVENTS (#)	RATE (%)	MILLIONS OF TONS
#5 continued							
Pickwick (Tenn)	130	231	5448	1255	214	50	17.8
Wilson (Tenn)	27	120	645	46	23	37	7.7
Wheeler (Tenn)	20	121	354	34	20	22	7.4
Guntersville (Tenn)	16	92	271	26	31	32	5.7
Nickajack (Tenn)	16	83	333	100	36	21	5.3
Chickamauga (Tenn) (3)	106	419	1365	65	29	52	3.3
Watts Bar (Tenn) (3)	42	332	275	27	42	29	1.9
Ft. Loudon (Tenn) (3)	52	188	245	163	49	17	0.6
Melton Hill (Clinch)	0	42	0	0	0	39	0.0
#6 GULF INTRACOASTAL							
Inner Harbor (GIWW) (1)	548	592	106551	1616	415	100	26.3
Harvey Lock (GIWW)	57	91	4012	137	285	47	3.5
Algiers Lock (GIWW)	217	262	36565	165	16	85	26.7
Bayou Boeuf (GIWW)	16	41	3841	170	60	56	27.2
Leland Bowman (GIWW)	51	74	12111	5	16	64	42.2
Calcasieu Lock(GIWW)	68	95	15661	265	291	72	N.A.
BrazosR.E.Gate(GIWW)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
BrazosR.W.Gate(GIWW)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
ColoradoR.E.Lk(GIWW)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
ColoradoR.W.Lk(GIWW)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Port Allen (GIWW)	77	136	6688	2402	139	78	19.2
Bayou Sorrel (GIWW)	62	90	5315	213	65	41	22.0
Jim Woodruff (ACF)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
George W Andrew(ACF)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Walter F George(ACF)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 1 (Pearl)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 2 (Pearl)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 3 (Pearl)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
#7 MOBILE RIVER & TRIBS							
Bankhead (BWT) (2)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Holt (BWT)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Wm Bacon Oliver(BWT) (1)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Selden (BWT)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Demopolis (BWT)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Coffeeville (BWT)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Claiborne(Ala-Coosa)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
MillersFerry(AlaCsa)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Robert Henry(AlaCsa)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Gainesville(TennTom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 3.1 continued

PERFORMANCE MONITORING SYSTEM - SELECTED INDICATORS

1987 PMS DATA FOR WATERWAY SYSTEM LOCKS

(SEE NOTES FOR STATUS OF LOCK IMPROVEMENTS)

SEGMENT NUMBER & NAME LOCK NAME & (RIVER)	AVERAGE DELAY TIME (MIN)	AVERAGE PROCESS TIME (MIN)	TOTAL DELAY TIME (HRS)	TOTAL STALL TIME (HRS)	TOTAL STALL EVENTS (#)	LOCK UTILIZ. RATE (%)	LOCK TRAFFIC MILLIONS OF TONS
#7 continued							
Aliceville (TennTom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Columbus (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Aberdeen (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock A (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock B (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock C (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock D (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock E (Tenn-Tom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bay Springs(TennTom)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
#8 ATLANTIC INTRACOASTL							
Great Bridge (AIWW)	4	23	60	0	0	25	0.5
South Mills (AIWW)	7	32	1	0	0	19	0.0
Deep Creek (AIWW)	4	28	0	0	0	28	0.0
#9 COLUMBIA-SNAKE							
Bonneville(Columbia) (1)	69	165	2373	18	16	53	8.9
The Dalles(Columbia)	9	50	225	19	9	17	7.5
John Day (Columbia) (2)	16	67	394	19	2	21	7.4
McNary (Columbia)	6	42	151	347	35	13	6.5
Ice Harbor (Snake)	11	47	253	374	80	17	3.8
Lwr Monumentl(Snake)	8	49	134	305	14	11	3.2
Little Goose (Snake)	5	36	76	243	4	8	3.1
Lower Granite(Snake)	4	34	59	263	7	10	2.2
Locks 1-4(Wilamette)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Guard Lock(Wlamette)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Notes: (1) Construction of replacement scheduled or underway
(2) Major rehabilitation recently completed or underway
(3) Replacement or improvement under study

TABLE 3.2

RECREATION USAGE OF THE INLAND WATERWAY SYSTEM

WATERWAY/LOCK NAME OR NUMBER	LOCK UTILIZATION RATE IN 1986 (%)	RECREATION LOCKAGES 3RD QTR 1986 (MAIN/AUX) (%) (1)	RECREATION UTILIZATION RATE (%) (2)
Upper Mississippi			
No. 1	69	51/25	35.2/17.3
No. 2	61	49	29.9
No. 3	60	56	33.6
No. 4	59	52	30.7
No. 5	57	50	28.5
No. 5a	57	56	31.9
No. 6	59	56	33.0
No. 7	60	57	34.2
No. 8	60	51	30.6
No. 9	59	52	30.7
No. 10	58	53	30.7
No. 11	56	55	30.8
No. 12	54	55	29.7
No. 13	52	48	25.0
No. 14	62	28/99	17.4/61.4
No. 15	45	6/86	2.7/38.7
No. 16	57	32	18.2
No. 17	58	26	15.1
Arkansas River			
L&D 3	21	53	11.1
L&D 4	18	48	8.6
L&D 5	21	64	13.4
David T Terry	23	77	17.7
Murray	20	79	15.8
Toad Suck	19	46	8.7
Arthur V Ormond	16	47	7.5
Dardanelle	18	53	9.5
Ozark	17	46	7.8
James W Trimble	21	42	8.8
W D Mayo	22	53	11.7
Robert S Kerr	25	56	14.0
Webbers Falls	27	51	13.8
Illinois Waterway			
Starved Rock	53	37	19.6
Marseilles	64	35	22.4
Dresden Island	53	35	18.6
T J O'Brien	38	77	29.3
Tennessee River			
Chickamauga	41	54	22.1
Watts Bar	29	60	17.4

1) The number of recreational lockages during July, August and September expressed as a percent of all lockages in these months.
2) Utilization rate times percent of recreation lockages.

PEAK LOCK & AVERAGE LOCK ANNUAL DELAY TIME

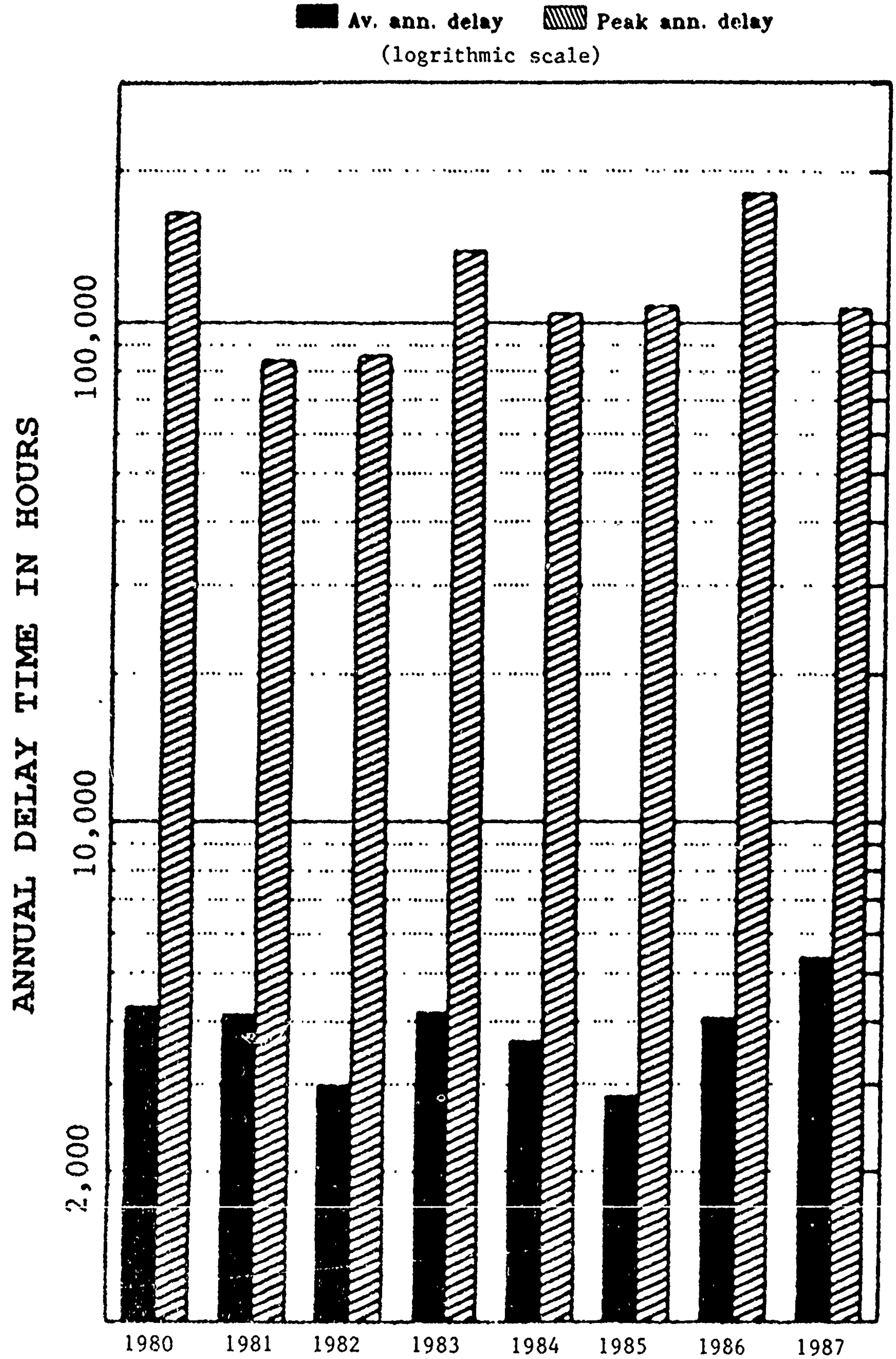


FIGURE 3.1

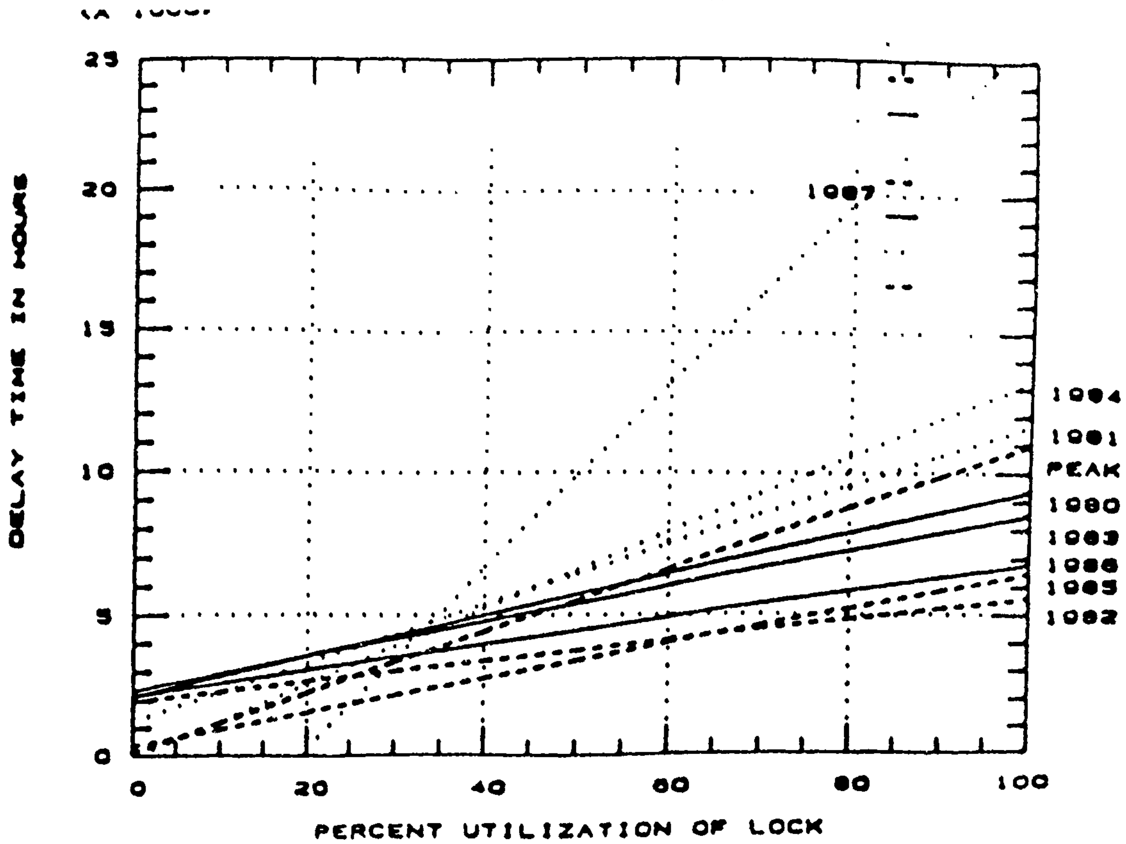


FIGURE 3.2
DELAY VS PERCENT UTILIZATION
FOR SELECTED YEARS

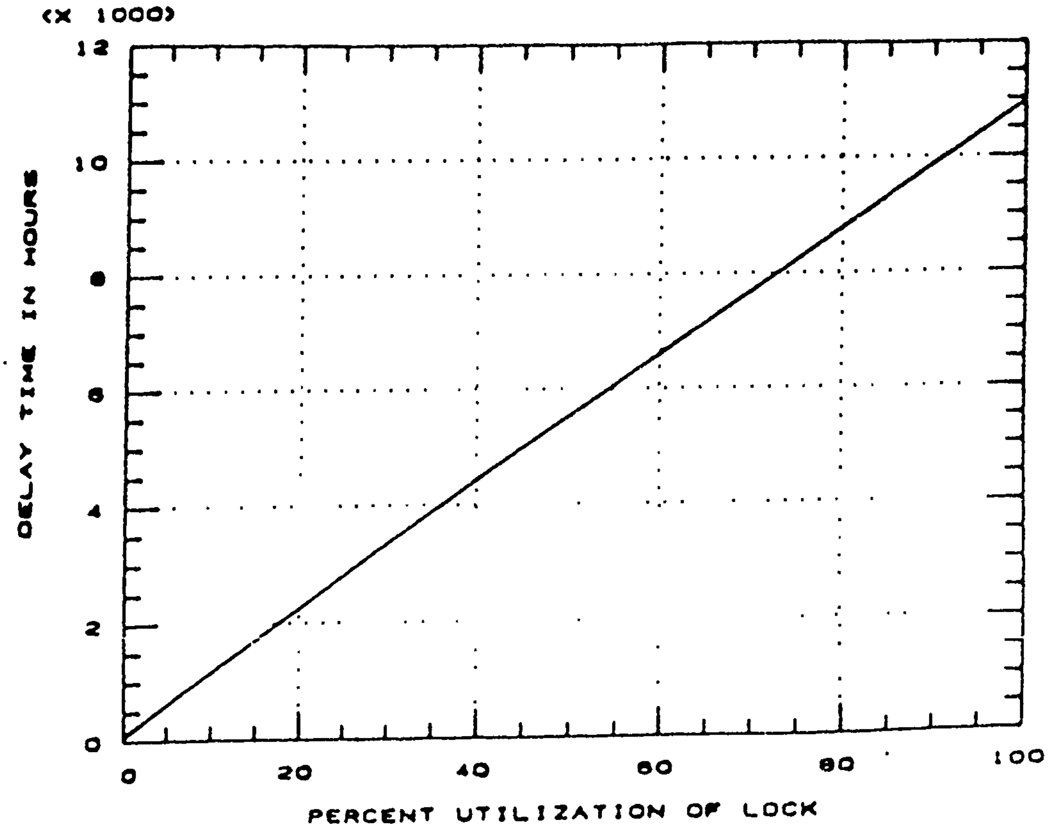


FIGURE 3.3
DELAY VS PERCENT UTILIZATION
BASED ON PEAK YEAR VALUES

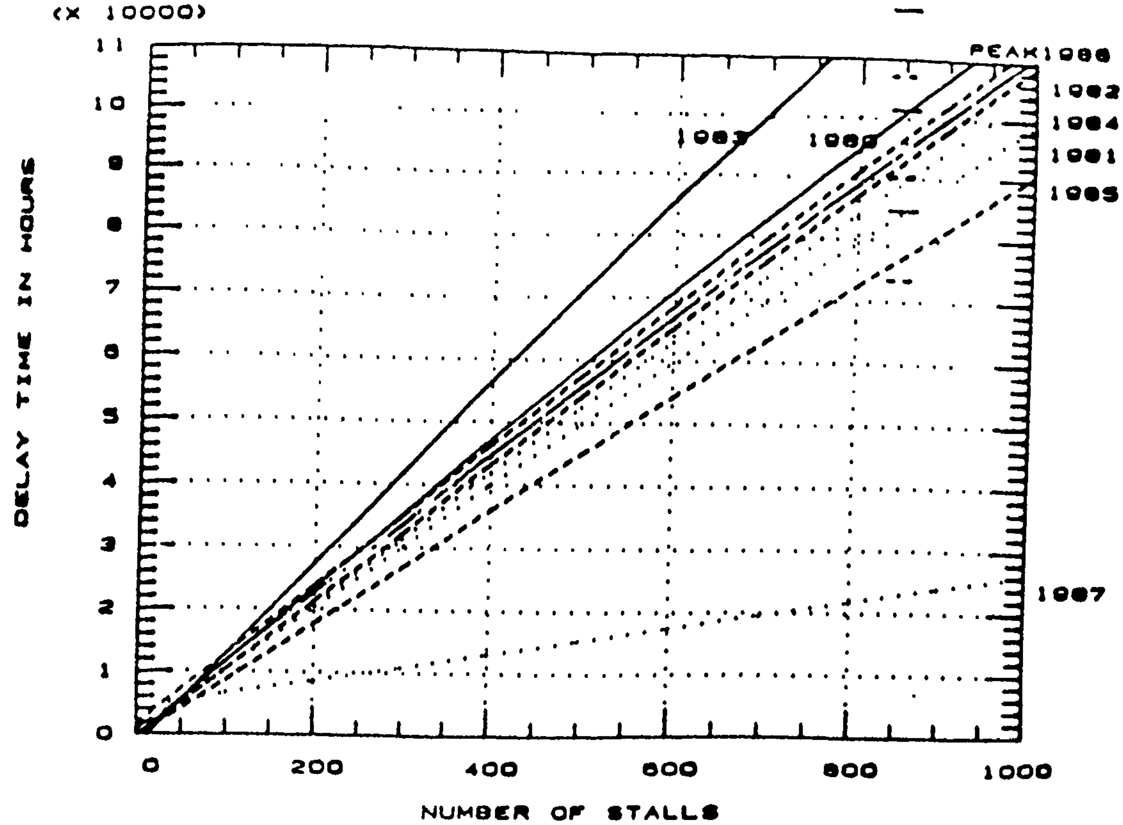


FIGURE 3.4
DELAY VS NUMBER OF STALLS
FOR SELECTED YEARS

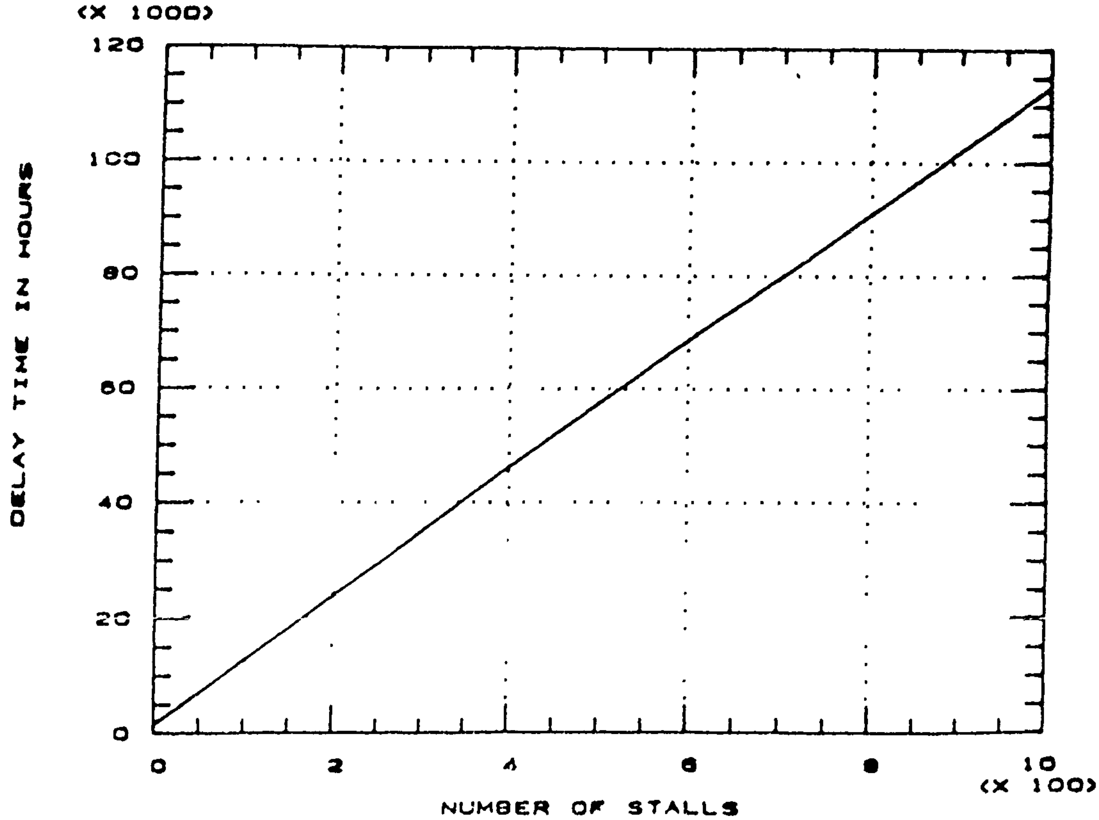


FIGURE 3 5
DELAY VS NUMBER OF STALLS
BASED ON PEAK YEAR VALUES

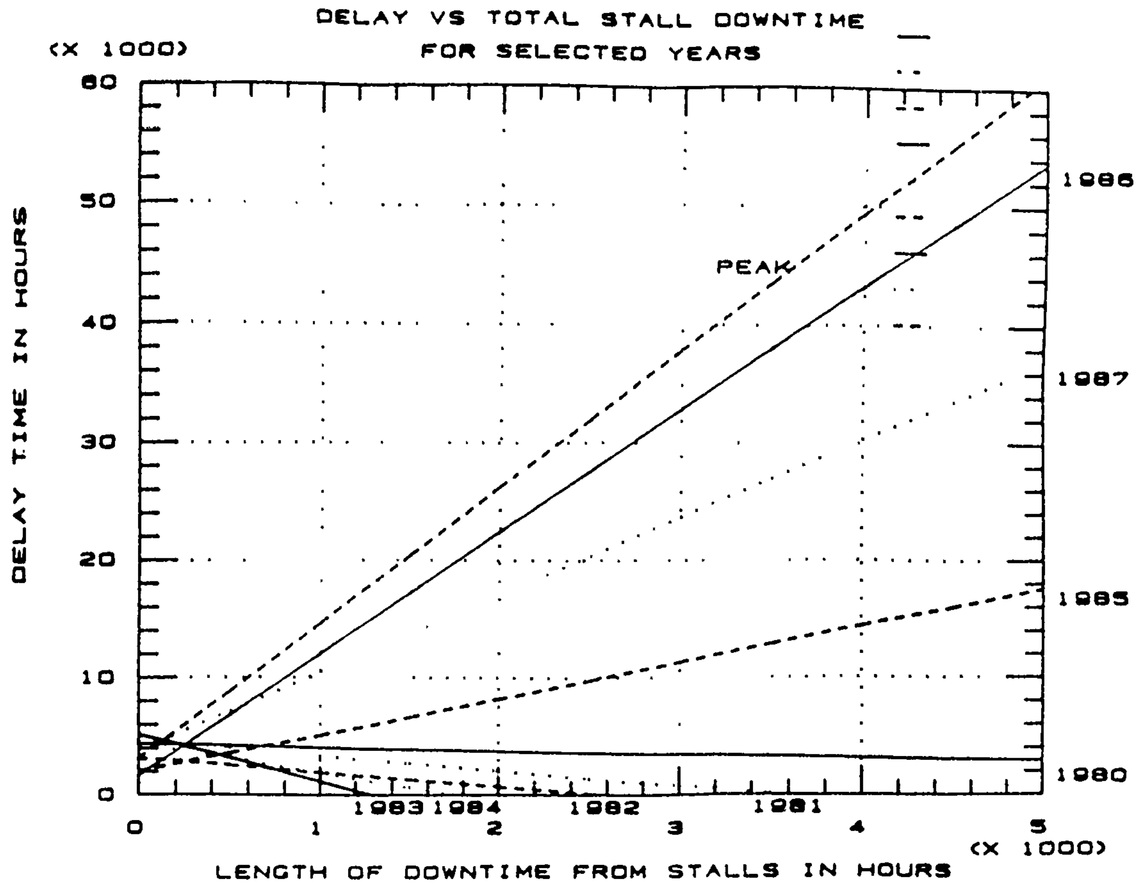


FIGURE 3.6

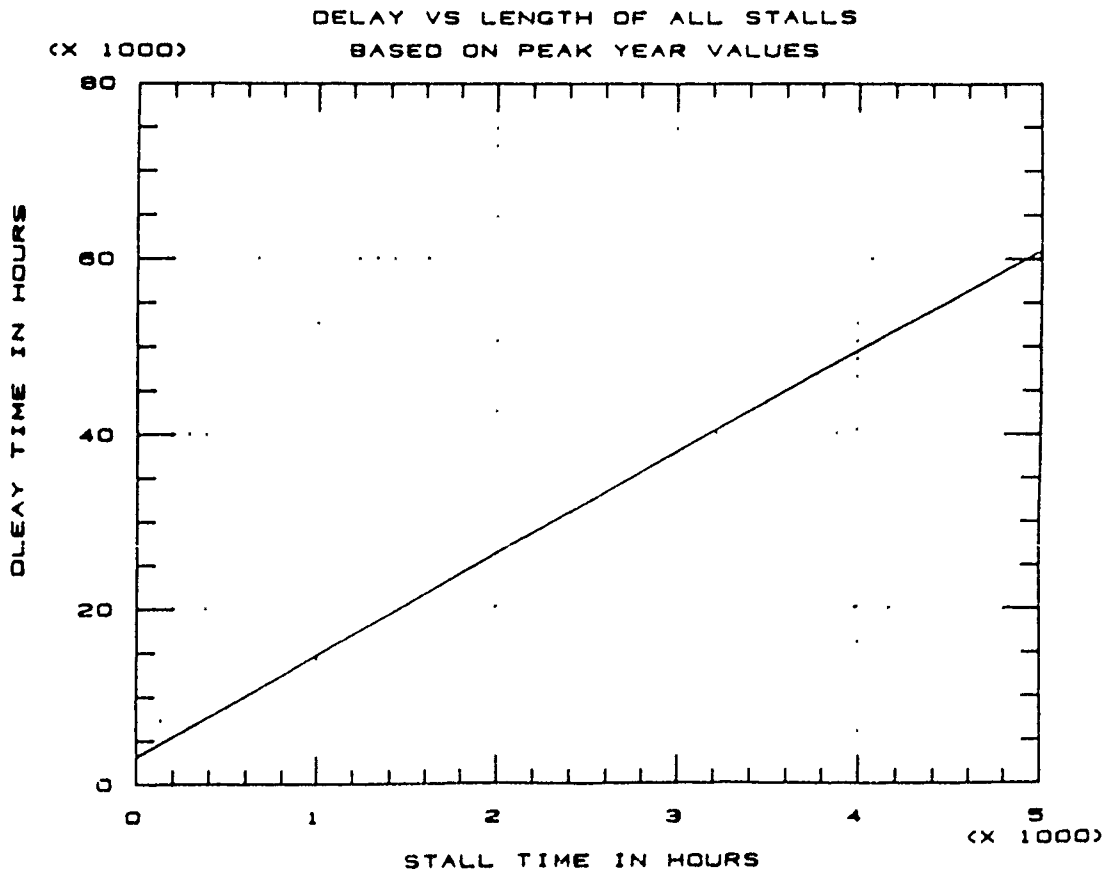


FIGURE 3.7

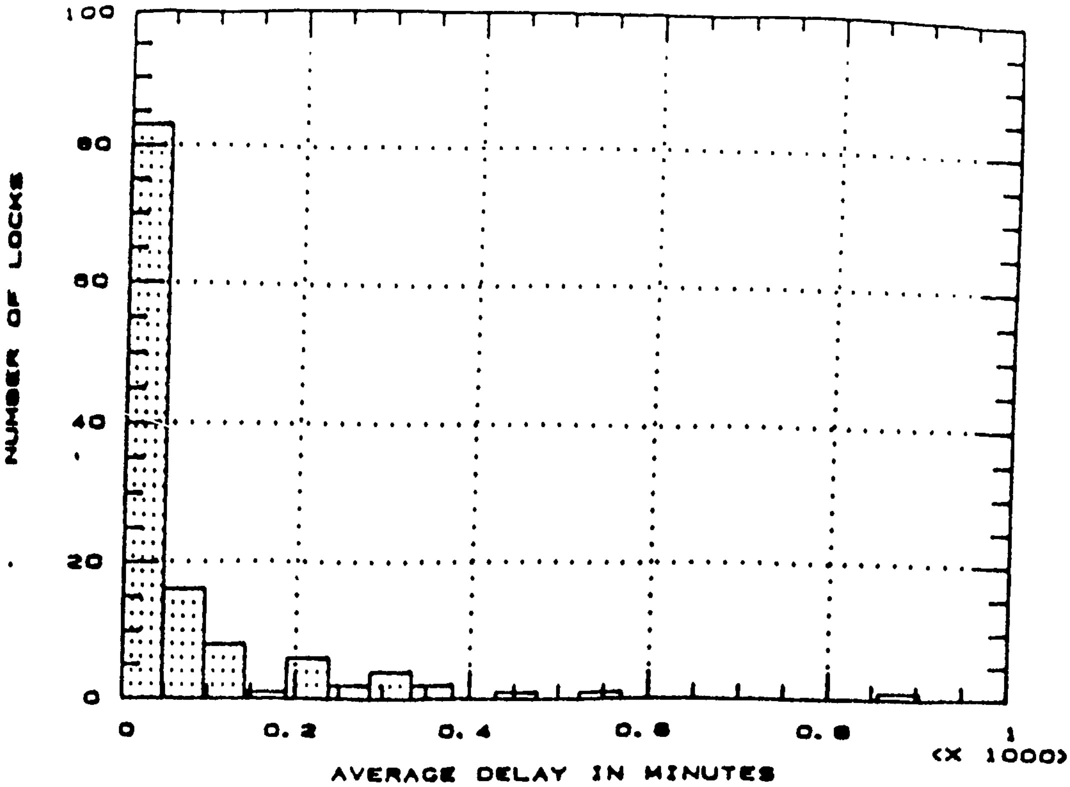


FIGURE 3.8
DISTRIBUTION OF AVERAGE DELAY TIME
SELECTED LOCKS 1987

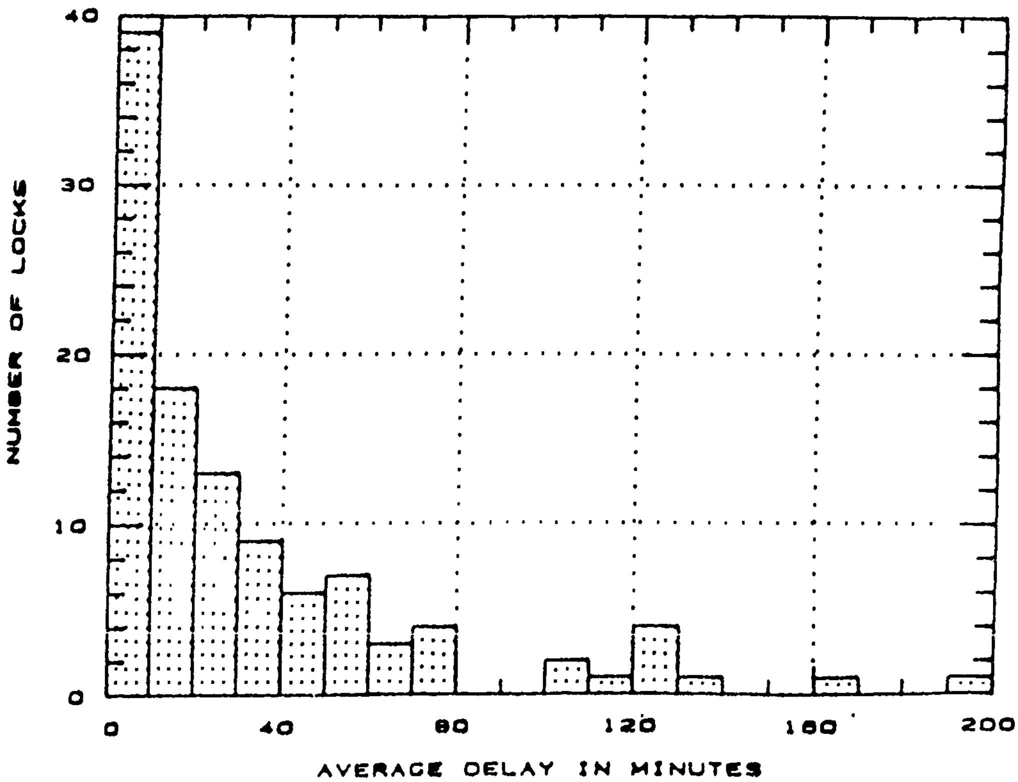


FIGURE 3.9
DISTRIBUTION OF AVERAGE DELAY TIME
LOCKS < 200 MINUTES AVERAGE DELAY 1987

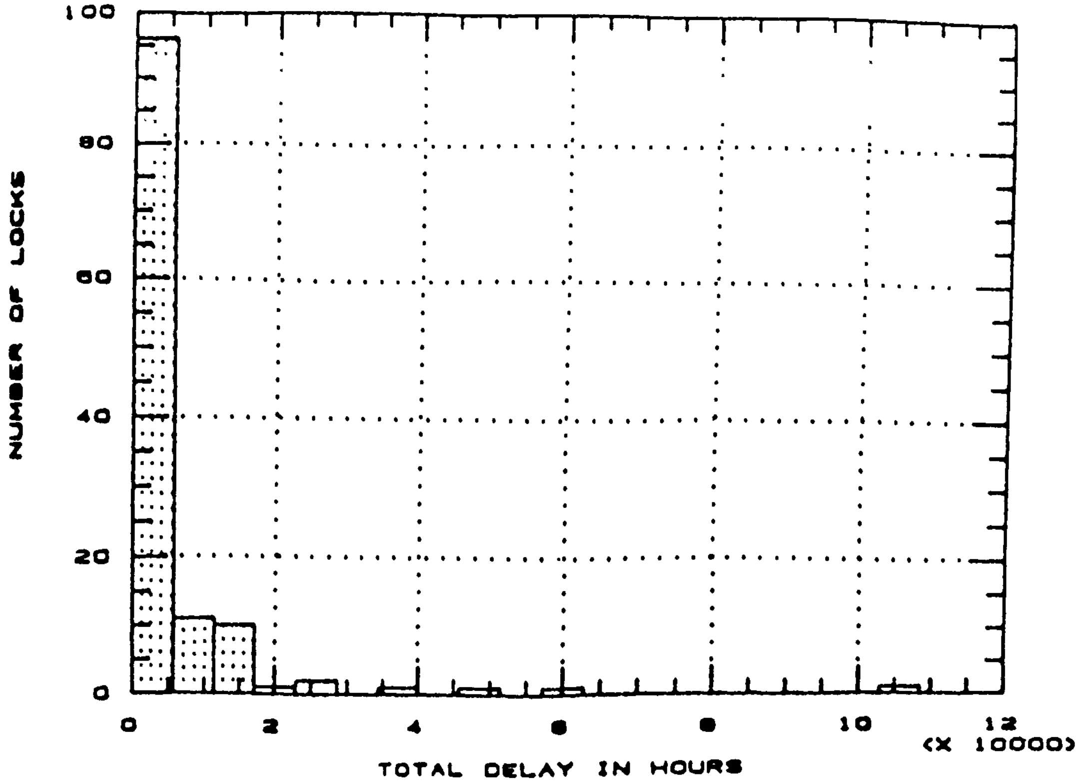


FIGURE 3.10
DISTRIBUTION OF DELAY TIME
SELECTED LOCKS 1987

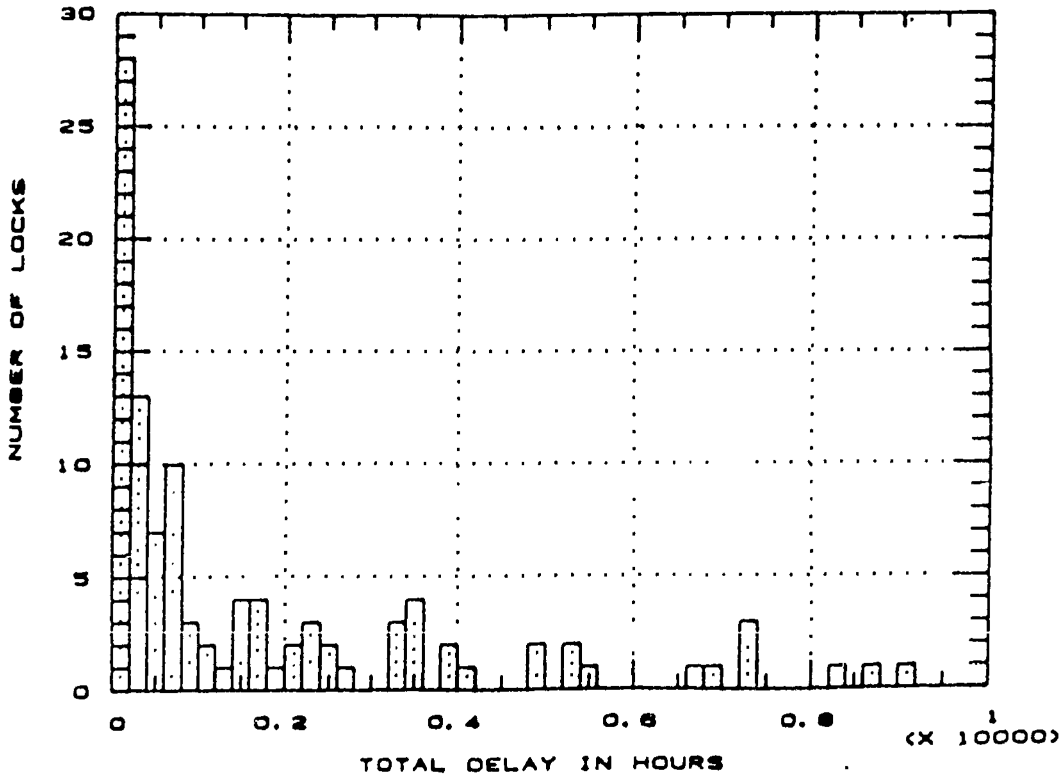


FIGURE 3.11
DISTRIBUTION OF TOTAL DELAY TIME
LOCKS < 10,000 HOURS 1987

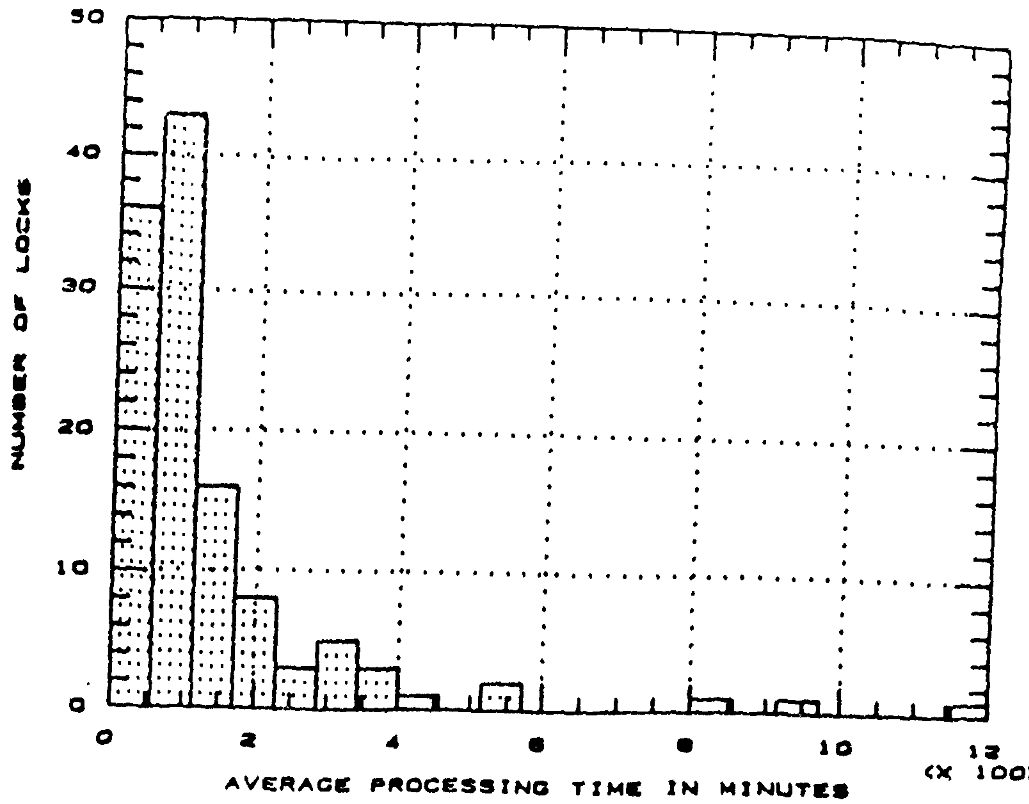


FIGURE 3.12
DISTRIBUTION OF AVERAGE PROCESSING TIME
SELECTED LOCKS 1987

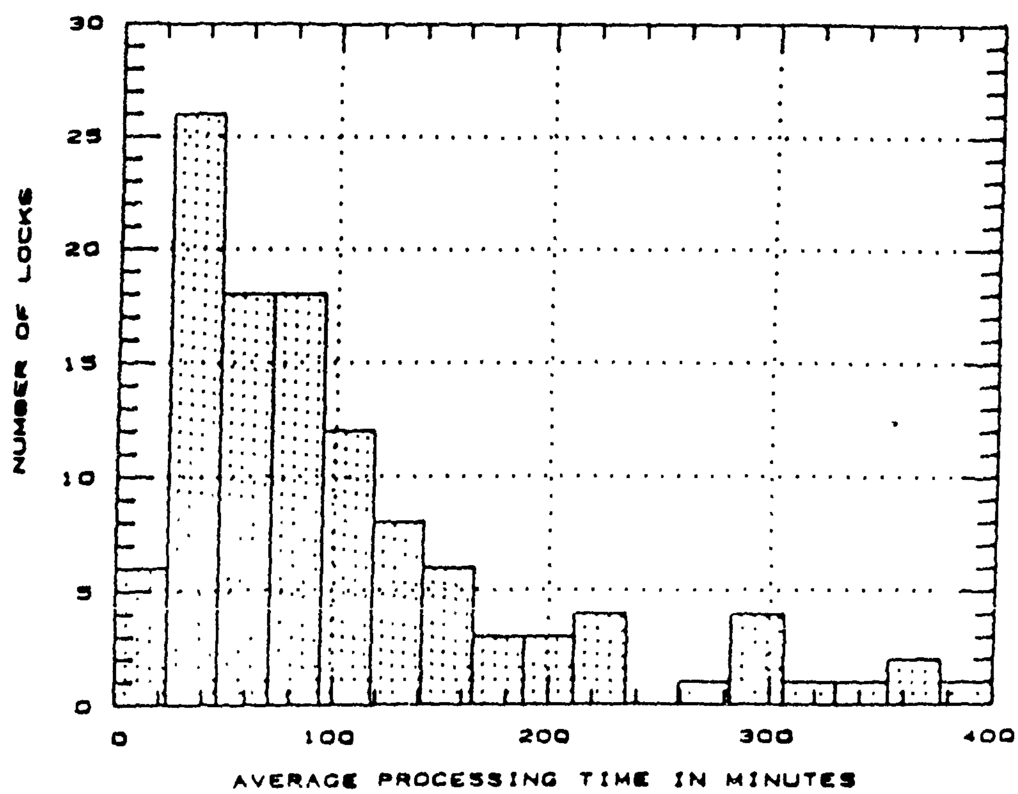


FIGURE 3.13
DISTRIBUTION OF AVERAGE PROCESSING TIME
LOCKS < 400 MINUTES 1987

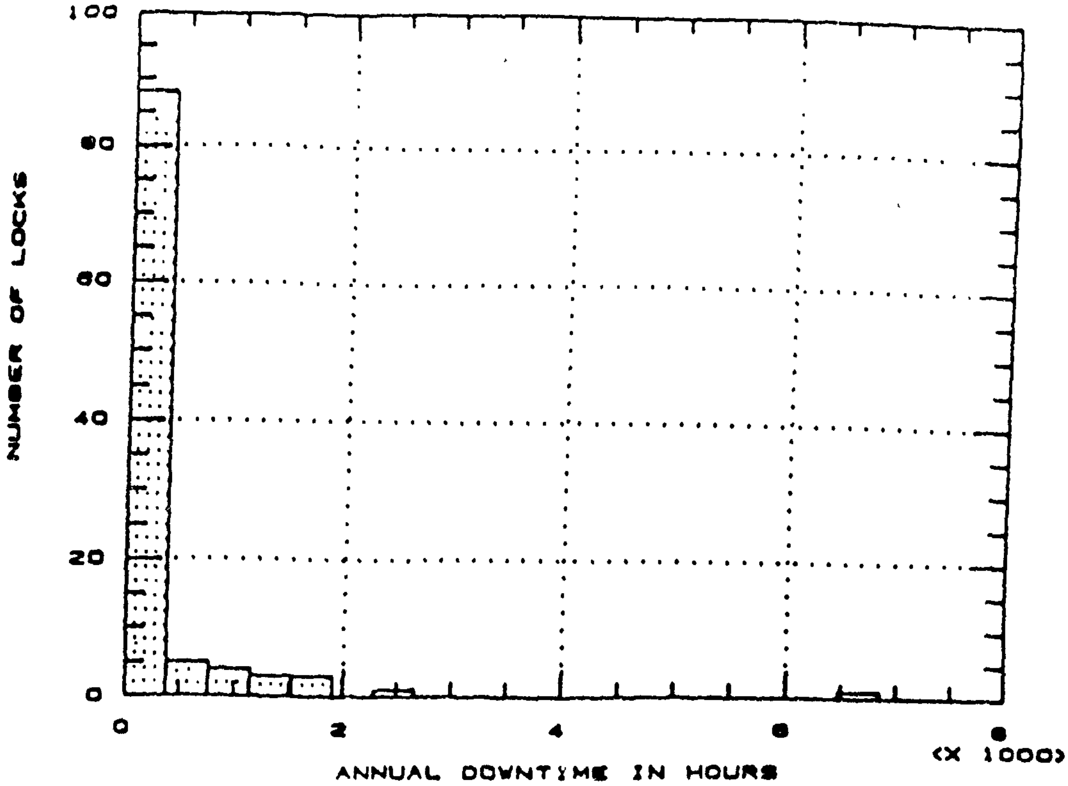


FIGURE 3.14
DISTRIBUTION OF ANNUAL DOWNTIME
SELECTED LOCKS 1987

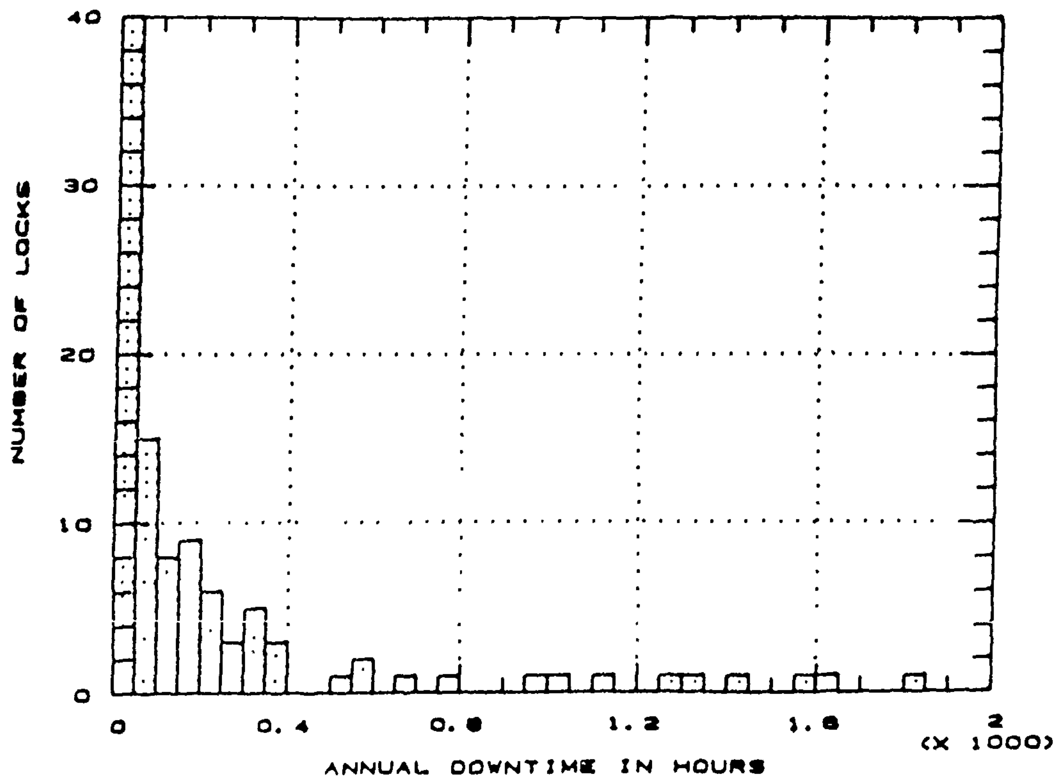


FIGURE 3.15
DISTRIBUTION OF ANNUAL DOWNTIME
LOCKS < 2000 HOURS DOWNTIME 1987

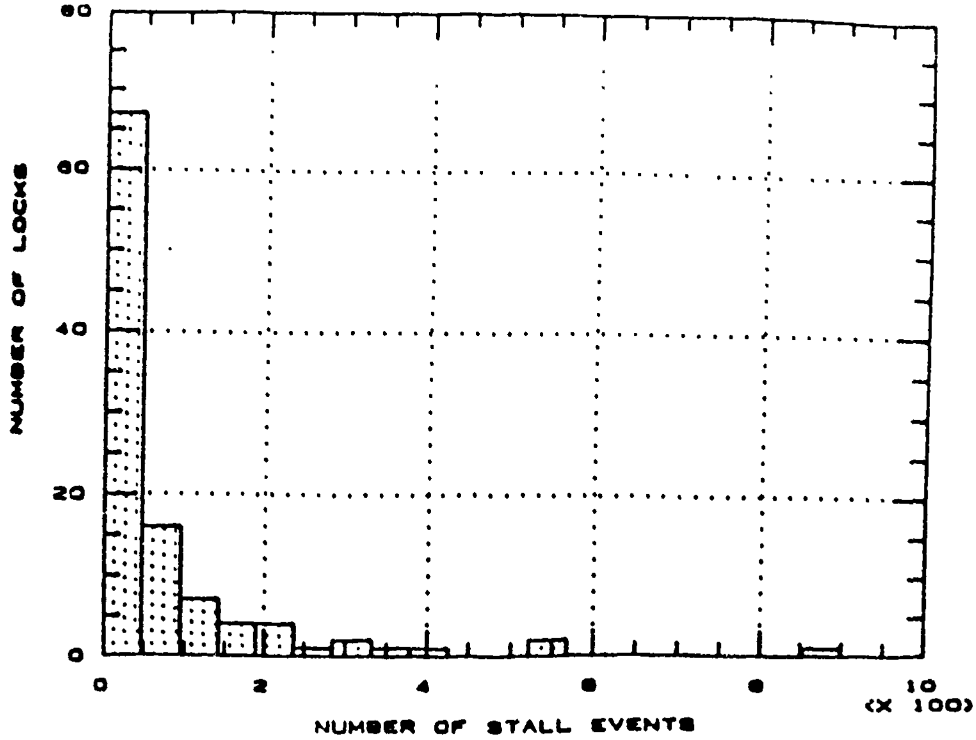


FIGURE 3.16

DISTRIBUTION OF ANNUAL STALL EVENTS
SELECTED LOCKS 1987

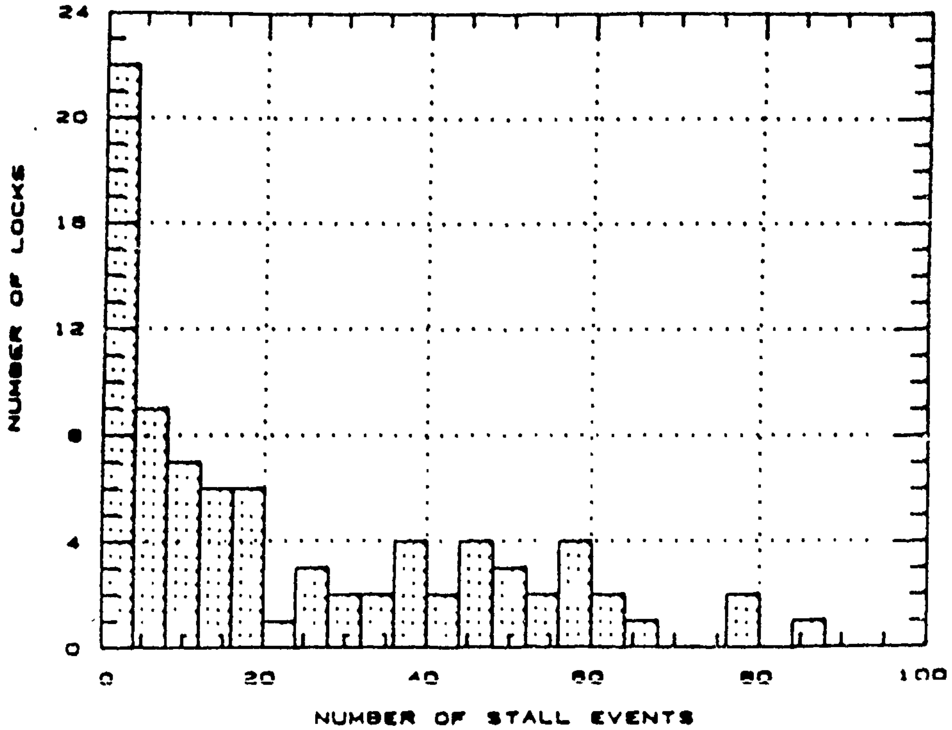


FIGURE 3.17

DISTRIBUTION OF ANNUAL STALL EVENTS
LOCKS < 100 EVENTS 1987

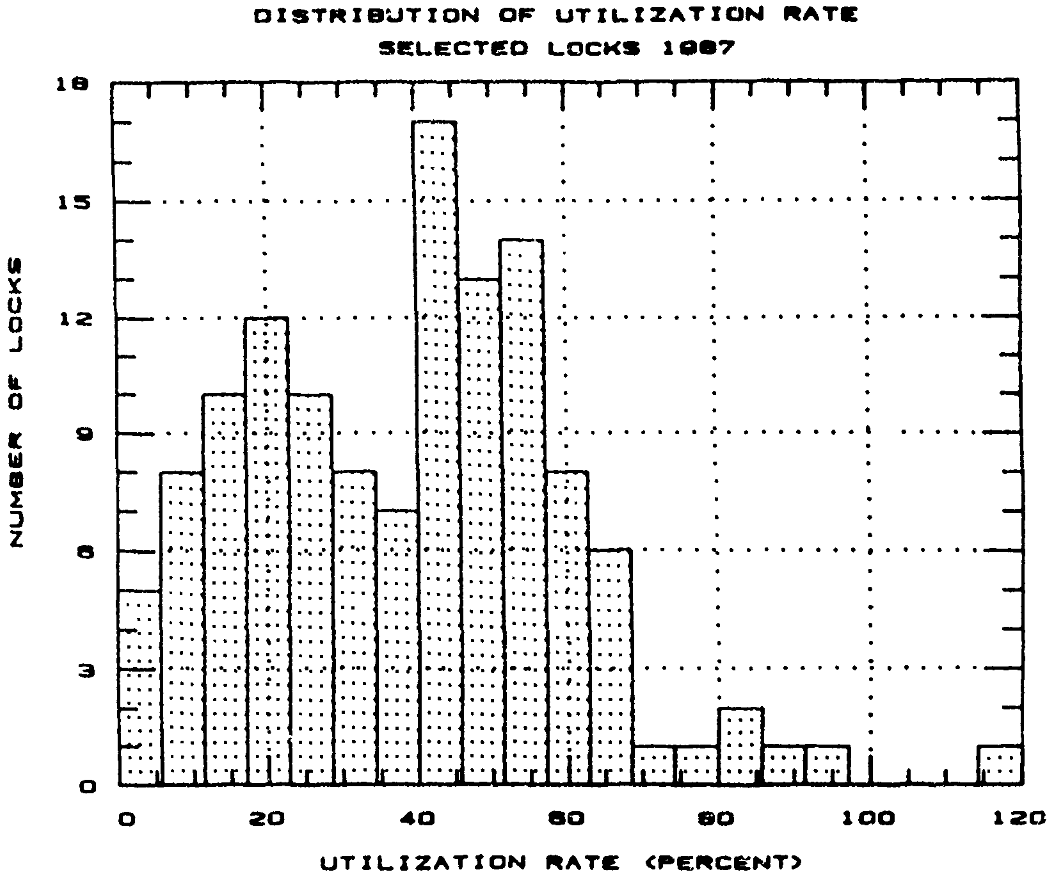


FIGURE 3.18

DISTRIBUTION OF UTILIZATION RATE

Chapter 4

PROGRAM REVIEW

BACKGROUND

The primary Federal interest in waterways is to facilitate the flow of domestic and international commerce. The Corps' objective is to manage the waterway system to enhance economic efficiency in consonance with the full range of existing environmental laws and regulations. The Corps operates the inland waterway projects to satisfy navigation and many other authorized water resources purposes, since flowing water must be managed for multiple uses.

Federal funding for the inland waterway system has remained essentially level during the 1980s. In this period of financial stringency, level funding is a strong signal of continued high priority for the inland waterways among domestic programs. As new construction of navigation segments are completed, there is a shift towards increased outlays for operations and maintenance. However in real terms, the O&M budget for inland waterways has shown very little increase. Thus the Corps is managing to do more with less. This is efficiency in the purest economic sense.

Table 4.1 and Figures 4.1 and 4.2 present more detail on the funding patterns for the inland waterways since 1980. To help the overall perspective, similar information for the total Corps of Engineers Civil Works program is presented in Table 4.1 and Figures 4.3 and 4.4. Inland waterways is a major component of the overall Civil Works program.

Several new Lock and Dam replacement projects have been initiated in accordance with the authority and policy contained in the Water Resources Development Act of 1986. Use of the Inland Waterways Trust Fund to fund 50 percent of new inland navigation construction projects has enabled a much more aggressive investment approach. The projects which have become inefficient due to lack of capacity and operational ineffectiveness are being replaced systematically with larger, more economical projects. The intent is to help the waterways become more efficient and economical.

OPERATIONS AND MAINTENANCE

Operations and maintenance costs for waterways subject to the fuel tax have increased by 81 percent in current prices and about 8 percent in real terms during the ten year period ending in 1986 (Table 4.2). During the same period ton-mile traffic increased by 17 percent. The nominal cost per ton-mile increased from 1.0 mill in FY77 to 1.5 mills in FY86 but, when costs are adjusted for inflation, there has been an 11 percent decline in real costs per ton-mile.

Table 4.2 presents O&M costs in current prices, traffic in ton-miles, and costs per ton-mile for nine waterway segments and for FY77, FY82, and FY86. Figures 4.5 and 4.6 display the share of ton-miles and O&M costs for each segment. Figure 4.7 compares the cost per ton-mile by segment. Only costs for fuel tax waterways are included for each segment. Historically, about 85 percent of all shallow draft O&M costs have been expended on fuel tax covered waterways.

The Lower Mississippi River and Ohio River System have the largest O&M outlays and lowest O&M costs per ton mile, since their traffic levels are higher. Figures 4.5, 4.6 and 4.7 and Table 4.2 show the data on O&M costs for each segment and ton-mile costs. Basically,

the data show that the high traffic volume waterway segments consistently show lower O&M costs per ton-mile than segments with less traffic volume. Overall, O&M costs averaged 1.5 mills per ton mile in FY86, and ranged from an average of .8 mills to 43 mills per ton mile.

MAJOR REHABILITATION

Several lock and dam structures have undergone rehabilitation, which could also be characterized as major maintenance. Table 4.3 displays twenty-seven major rehabilitation projects that are complete or are currently being constructed. Over $340 million has already been spent over the period FY78 to FY88 for lock and dam major rehabilitation. Approximately another $123 million will be required to complete the 12 projects currently under construction. The President's Budget for FY89 includes $40 million to continue these projects.

The greatest number of recent rehabilitation projects are in the river segments that are heavily used and contain old structures. A majority of the chambers on the Upper Mississippi River are 50 years or more old. This river has 12 separate rehabilitation projects completed or underway. Five structures on the Illinois River have been rehabilitated in the last decade, while two projects at Peoria and LaGrange are currently underway. Six of the 27 major rehabilitation projects are located on the Ohio River system. Five of these projects (four on the Ohio River and one on the Monongahela River) have been completed. The Black Warrior and the Columbia-Snake, have each had one major rehabilitation project recently completed.

There is now an ongoing effort by the Corps to revise major rehabilitation guidance. As part of this effort, a review of the potential work that could be categorized as rehabilitation for funding as construction has been performed. That review indicates that such potential work approximates $125 to $250 million.

A significant R&D program (called REMR) is now underway with primary objectives of (1) improving the technology (and reducing costs) of maintenance and repair and (2) developing a more systematic basis for programming and managing the Corps Civil Works repair and maintenance outlays.

CONSTRUCTION

Nine projects on the fuel-taxed waterways have been scheduled for construction following authorization of eight of them by the WRDA of 1986 and authorization of Olmsted Locks and Dam this year. These new projects (Table 4.4) will reduce traffic delays and lower the cost of waterway transportation far in excess of their estimated costs of $2.9 billion (fully funded estimate).

There are several ongoing construction projects for inland navigation which are not authorized to be funded through the waterways trust fund. The first lock at L&D 26 will be completed in 1989. In the reach below L&D 27 at St. Louis, training works to maintain navigable depths are under construction. The MR&T project receives continuing outlays to complete bank protection and other works required to maintain navigation. The four new locks and dams on the Ouachita-Black River have been completed, but there is continuing channel improvement work. The Red River project is under construction to Shreveport. LA. These and other projects are shown in Table 4.5. If all of these projects are funded to completion, there remains an unscheduled balance of $4.5 billion.

STUDIES

These are nine studies of sixteen potential lock and dam and four potential channel improvements now underway that are expected to be completed between FY88 and FY93. Future construction projects on the inland waterways are dependent on favorable feasibility studies. These studies are likely to identify projects that will be available for construction after 1993.

An analysis of the future balance of the Waterways Trust Fund in June 1988 showed prepared for the fourth meeting of the Inland Waterways Users Board, the limits of trust fund liquidity. There appears to be a significant limit on the number and pace of additional construction of inland navigation projects after the nine now scheduled for contributions from the Trust Fund are completed. An estimate of the revenues for the fuel tax is from $100-150 million per year in the early part of the first decade following the year 2000. Assuming continuation of the policy to fund 50 percent of the cost of new inland projects from the Trust Fund, average outlays would be limited to $200-300 million per year. If the 12 projects now under study in the Ohio River System are placed in construction after they become available for construction, the trust fund income would constrain completion of the projects until 2023 (assuming no additional projects are started). Therefore, a budget priority strategy which invests available funds in projects with the greatest net benefits to the entire system will be required.

Twelve projects now under study in the Ohio River system will probably recommend construction of replacement projects. Preliminary estimates of costs are estimated to be 2.3 billion, including an allowance for inflation in future construction costs. Table 4.6 shows more information about these projects.

In addition to the Ohio River system studies, there are investigations to extend navigation up the Columbia River above the Dalles, study of a lock and dam on the lower White River (a part of the McClellan Kerr/Arkansas River Navigation System). There is no strong indication that these studies will recommend new construction.

The capacity analysis conducted for this report supports new studies to begin in FY89 on the Upper Mississippi and Illinois Rivers. Ongoing studies on the GIWW between New Orleans and Galveston and new studies for Algiers and possibly Calcasieu locks are also supported by this report.

Small Scale Capital Improvements. The Corps has included analysis of small scale (often called nonstructural) measures to improve the efficiency and speeds of tows moving through locks or constrained channels. These measures may become more attractive to water carriers and shippers if construction budgets remain constrained.

An example of a comprehensive assessment from the 1982 Comprehensive Master Plan for Management of the Upper Mississippi River System is presented here to illustrate some of the concepts which may have merit under certain conditions. The results of this assessment do not represent a consensus position of the Corps of Engineers and probably not fully supported by carriers and shippers.

The study assessed steps that could be taken to increase capacity or throughput of certain locks on the Upper Mississippi and Illinois Rivers by employing certain non-structural measures and making minor structural improvements. These actions broadly include scheduling of lock operations and assistance to multicut lockages, improvements to approaches, tow configuration and operation, lock operating controls, and structural actions (Table 4.7). The low cost non-

structural measures and minor structural improvements may also be applicable at other locks on other waterways in the system, depending on the results of thorough project planning studies.

In the Comprehensive Water Plan, a wide range of capacity expansion measures was considered for study in the capacity analysis. These measures were used to construct the four basic system scenarios which were evaluated. An inventory was conducted of potential structural and non-structural measures that could be instituted to increase the ability of the system to handle additional traffic. Forty-three measures were initially identified. Ten were eliminated from further consideration due to their low impact on capacity, high cost, safety problems, or availability of information needed to quantify performance. The remaining 33 measures were further screened and prioritized, resulting in a list of eleven measures used in the design of system capacity expansion scenarios (Table 4.8). These remaining eleven measures included both structural and non-structural options with a wide range of costs and capabilities.

ENVIRONMENTAL PLANNING FOR INLAND WATERWAYS

The federal management objectives for the Nation's inland waterway system are rooted in the principles of multipurpose planning, utilization, and operation. While the needs to operate the inland waterway system safely and efficiently remain paramount, economic, social, environmental, and National defense considerations are routinely balanced within the environmental planning equation. The needs of commercial and recreational users must be addressed, along with flood control, hydropower, bank stabilization, and resource management considerations.

Therefore, extensive coordination and informational exchange programs form the cornerstone of environmental planning efforts. This philosophy essentially compliments requirements of the National Environmental Policy Act of 1969 (as amended) and a list of key related statutes provided in Appendix B. Through application of Corps internal regulations pursuant to the Council on Environmental Quality's (CEQ) regulations (40 CFR Part 1500-1508), environmental planning for the Nation's inland waterways by the Corps is fully responsive to the challenges of the future.

The Corps' organization is staffed with a multidisciplinary workforce from the fields of engineering, environmental sciences, social sciences, and physical sciences, who are sensitive to environmental concerns related to planning, design, construction, and operation activities. Using a team approach, the Corps identifies, evaluates, and implements management activities for environmental enhancement and protection measures. Internal policies and regulations require efforts to avoid or minimize undesired effects to the extent possible under a multipurpose use philosophy.

The Corps follows a two-phase planning process for new projects as defined in the document entitled Principles and Guidelines. Management requirements under "Initiatives 88", a Corps-wide program of efficiency measures, is being used, as appropriate, for planning and design efforts with a view toward maintaining environmental quality. The two-phase planning process, for example, is comprised of a reconnaissance phase and a feasibility phase.

The purpose of the reconnaissance phase is to: (1) identify at least one potential solution; (2) affirm Federal authority and interest in a solution; and (3) identify, if required, a cost-sharing partner for subsequent feasibility study.

These critical issues are addressed in a reconnaissance report.

During the feasibility phase, various project alternatives are examined in light of engineering, economic, and environmental principles. The feasibility study typically requires a refinement of the understanding of the problem, and impact assessment based upon discrete data analysis and detailed environmental studies. The resulting feasibility report will contain a recommendation for the administration and Congress to consider, possibly leading to detailed design and construction.

Normally, feasibility studies will require an Environmental Assessment or an Environmental Impact Statement (see Appendix B). A Fish and Wildlife Coordination Act Report prepared by the U.S. Fish and Wildlife Service is included which describes the resource base, evaluates effects, and makes recommendations concerning fish and wildlife resources.

For projects operated by the Corps (i.e., waterways and reservoirs), master plans, land use allocation plans, annual work plans, and shoreline management plans are effective tools for wise environmental resource management. The Corps also administers a permit program to regulate structures and fill for navigable waters. Environmental evaluations are key components of all of the above management tools. Finally, the Corps expends significant efforts to manage Federal lands through the execution of studies, enhancement, protection, and interpretive measures.

Appendix B of this report provides a description of environmental planning considerations related to navigation and the inland waterways system.

Throughout the planning, design, construction, and operations aspects of any project, the Corps continues to evaluate and advance environmental considerations. When necessary the Corps will conduct environmental reevaluation studies as well as supplement an existing EIS to meet changing conditions. The Corps has a strong commitment to protecting and enhancing the quality of the environment and this is in evidence as one considers its project development process.

Appendix B of this report provides an overview of the environmental impacts related to navigation and the inland waterways system. This appendix also contains a description of the process required for meeting NEPA guidelines and a list of Corps studies that demonstrate the array of work in this area.

TABLE 4.1

FEDERAL INLAND WATERWAYS AND CIVIL WORKS INVESTMENT 1980-1988[1]
(Millions of Dollars)

Fiscal Year	Inland Waterways Navigation Construction $	O&M $	Total $	Total Civil Works Construction $	Inland %	O&M $	Inland %
1980	427	262	689	1660	26	942	28
1981	422	281	703	1594	26	968	29
1982	432	298	730	1430	30	1025	29
1983	359	338	697	1508	24	1201	28
1984	314	379	693	927	34	1185	32
1985	301[2]	406	707	948	32	1308	31
1986	254	413	667	880	29	1260	33
1987	218[3]	437	655	1149	18	1390	31
1988	317[4]	454	771	1200[4]	26	1455[5]	31

SOURCE: U.S. Army Corps of Engineers, CECW-BW, June 1988

[1] U.S. Army Corps of Engineers Appropriations for Civil Works (includes all projects, including those subject to the fuel tax).
[2] Includes $7.8 million from Inland Waterways Trust Fund.
[3] Includes $26.0 million from Inland Waterways Trust Fund.
[4] Includes $38.0 million from Inland Waterways Trust Fund.
[5] Includes $16.3 million to be appropriated from the Harbor Maintenance Trust Fund. It was created by the 1986 Water Resources Development Act, which also authorized not more than 40 percent of annual O&M costs for harbors to be appropriated from this Fund.

TABLE 4.2

SUMMARY OF CURRENT OPERATIONS AND MAINTENANCE COSTS*

SEGMENT/WW	O&M COSTS 1977	1982	1986	TON MILES 1977	1982	1986	O&M COSTS PER TON-MILE 1977	1982	1986
	.... $million			.... million			..... $/ton-miles		
1 UPR MISS	25.9	38.9	53.5	11,380.5	14,630.2	12,871.9	0.0023	0.0027	0.0042
(% of Total)	14%	16%	16%	6%	7%	6%			
2 MDL MISS	17.5	14.3	16.9	14,018.1	16,800.6	17,504.7	0.0012	0.0009	0.0010
(% of Total)	9%	6%	5%	8%	9%	8%			
3 LWR MISS	50.4	61.8	84.2	75,369.1	89,578.6	100,058.3	0.0007	0.0007	0.0008
(% of Total)	27%	25%	25%	42%	46%	44%			
4 ILLINOIS	9.2	13.0	12.6	8,046.6	7,808.9	8,505.9	0.0011	0.0017	0.0015
(% of Total)	5%	5%	4%	4%	4%	4%			
5 OHIO	42.8	59.5	87.2	45,528.6	44,916.6	61,603.6	0.0009	0.0013	0.0014
(% of Total)	23%	24%	26%	25%	23%	27%			
6 GIWW	22.8	33.9	37.8	19,820.1	16,397.8	19,119.6	0.0011	0.0021	0.0020
(% of Total)	12%	14%	11%	11%	8%	8%			
7 MOBILE	7.5	16.2	23.3	4,671.1	4,741.3	5,746.2	0.0016	0.0034	0.0041
(% of Total)	4%	7%	7%	3%	2%	3%			
8 AIWW/IWW	8.6	7.9	15.8	630.6	376.4	367.1	0.0136	0.0210	0.0430
(% of Total)	5%	3%	5%	0.3%	0.2%	0.2%			
9 COL/SNK/WIL	3.1	3.3	9.0	1,439.3	1,331.5	1,228.2	0.0022	0.0025	0.0073
(% of Total)	2%	1%	3%	1%	1%	1%			
TOTAL	187.7	248.8	340.2	180,903.9	196,581.8	227,005.6	0.0010	0.0013	0.0015
	100%	100%	100%	100%	100%	100%			

SOURCE: O & M Costs - User Charge Data Base
Ton Miles - U. S. Army Corps of Engineers, WCSC, Waterborne Commerce of the U. S.

* o This is an excerpt from the more comprehensive O & M cost table in Appendix A which displays values for nine-year period (1977-1985), and for rivers under each segment.
o Inflation factor from 1977-1985 according to "Implicit Price Deflator based on overall GNP (OMB Series)" is about 65 %.
o Fuel tax waterways only.

TABLE 4.3

MAJOR REHABILITATION PROJECTS: COMPLETED AND UNDER CONSTRUCTION

SEGMENT/WATERWAY PROJECT	START DATE	COMPLETE DATE	COST (million)
UPPER MISSISSIPPI RIVER			$162.6
L&D 1	1978	1982	44.6
L&D 3,5A-9 (6 sites)*	1987	1994	37.7
L&D 14 (AUX)	1978	1982	7.8
L&D 19 (AUX)	1977	1980	5.2
L&D 20*	1986	1990	38.4
L&D 21*	1987	1989	13.8
L&D 22*	1987	1989	15.1
ILLINOIS WATERWAY			$133.0
LOCKPORT L	1983	1987	22.7
BRANDON ROAD L&D	1984	1988	23.8
DRESDEN L&D	1978	1983	16.7
MARSEILLES D	1985	1988	15.0
STARVED ROCK L&D	1978	1985	13.3
PEORIA L&D*	1986	1990	21.2
LA GRANGE L&D*	1986	1990	20.3

SEGMENT/WATERWAY PROJECT	START DATE	COMPLETE DATE	COST (million)
OHIO RIVER SYSTEM/OHIO RIVER			$117.6
EMSWORTH L&D	1982	1986	37.9
DASHIELDS L&D*	1986	1991	34.0
MONTGOMERY L&D	1985	1988	32.2
L&D 52	1980	1984	8.9
L&D 53	1980	1985	4.6
OHIO RIVER SYSTEM/MONONGAHELA R.			$16.0
L&D 3	1978	1982	16.0
MOBILE R&T/BLACK WARRIOR RIVER			$47.3
BANKHEAD	1966	1980	47.3
COLUMBIA-SNAKE WW/COLUMBIA RIVER			$6.2
JOHN DAY L	1980	1983	6.2

SUMMARY OF MAJOR REHABILITATION PROJECT STATUS

	#	COST THRU FY1988	FUTURE COST	TOTAL COST
		million		
PROJECTS COMPLETED THRU FY88	15	287.2	0.0	287.2
*PROJECTS UNDER CONSTRUCTION	12	84.3	111.2	195.5
TOTAL	27	$371.5	$111.2	$482.7

TABLE 4.4

SCHEDULED CONSTRUCTION PROJECTS IN THE FY1988 BUDGET

THAT DRAW FUNDS FROM INLAND WATERWAYS TRUST FUND

(MILLIONS OF DOLLARS AS OF OCTOBER 1987)

SEGMENT/PROJECT	START/ COMPLETION YEAR	PERCENT COMPLETE	FULLY FUNDED PROJECT COST	TOTAL ALLOCATIONS THRU FY88	ALLOCATION FOR FY89	UNALLOCATED BALANCE THRU FY89	REMARKS
UPPER MISSISSIPPI RIVER							
Miss. R., L&D 26--2nd Lock	1986/1992	6%	$213	$12	$13	$188	Replacement project
OHIO RIVER SYSTEM							
Ohio R., Gallipolis L&D	1985/1991	20%	$336	$70	$60	$206	Replacement project
Monongahela R., L&D 7	1987/1993	6%	$167	$10	$14	$143	Replacement project
Monongahela R., L&D 8	1987/----	2%	$94	$2	$3	$89	Replacement project
Kanawha R., Winfield L&D	1987/----	2%	$178	$3	$7	$168	Additional lock
Olmsted L&D (replaces L&D 52 & 53)	----/----	0%	$970	$6	$3	$961	Not yet authorized
MOBILE RIVER & TRIBUTARIES							
Black Warrior R., Oliver L&D	1987/199[illegible]	33%	$121	$40	$31	$50	Replacement project
GULF INTRACOASTAL WATERWAY							
Gulf Outlet, Inner Harbor Lock	----/----	13%	$685	$90	$1	$594	Replacement project
COLUMBIA-SNAKE WATERWAY							
Columbia R., Bonneville L&D	1985/1992	32%	$212	$34	$42	$136	Replacement project
T O T A L	N.A.	N.A.	$2,976	$27	$174	$2,535	

SOURCE: Appendix A: Description of the Waterway Segments

TABLE 4.5

SCHEDULED CONSTRUCTION PROJECTS IN THE FY 1988 BUDGET THAT DO NOT DRAW FUNDS FROM THE INLAND WATERWAYS TRUST FUND

(MILLIONS OF DOLLARS AS OF OCTOBER 1987)

SEGMENT/PROJECT	START/ COMPLETION YEAR	PERCENT COMPLETE	FULLY FUNDED PROJECT COST	TOTAL ALLOCATIONS THRU FY88	ALLOCATION FOR FY89	UNALLOCATED BALANCE THRU FY89	REMARKS
UPPER MISSISSIPPI RIVER							
Miss. R., L&D 26--1st Lock	1979/1989	75%	$755	$565	$50	$140	Replacement project
MIDDLE MISSISSIPPI RIVER							
Miss. R., Regulating Works	1910/2000	63%	$187	$118	$4	$65	Dikes, revetments, & dredg
LOWER MISSISSIPPI RIVER							
Miss. R. Channel Improvement	1928/2010	54%	$3,076	$1,666	$95	$1,315	Dikes and revetments
Arkansas R.	1963/1970	99%	$563	$548	$4	$11	
Ouachita-Black Rivers	1964/1984	83%	$275	$227	$2	$46	All 4 locks are open
Red R., Mouth to Shreveport, LA	1973/----	51%	$1,732	$883	$118	$731	Two locks are open
Atchafalaya R.	1928/2010	41%	$1,468	$592	$31	$845	Dikes and revetments
OHIO RIVER SYSTEM							
Ohio R., Smithland L&D	1970/1980	100%	$274	$274	$0	$0	Replacement project
MOBILE RIVER & TRIBUTARIES							
Coosa R. to Gadsden, AL	1977/----	2%	$1,359	$25	$0	$1,334	$25M exepnded for AE&D availability unknown
T O T A L	N.A.	N.A.	$9,689	$4,898	$304	$4,487	

SOURCE: Appendix A: Description of the Waterway Segments

TABLE 4.6

STUDIES OF POTENTIAL CONSTRUCTION PROJECTS

(MILLIONS OF DOLLARS AS OF OCTOBER 1987)

Segment Waterway/Project	Start Year	Complete Year	%	Project Cost Est.	Year Avail for Const.	Probable Improvement
Ohio River System						
Ohio/Emsworth	1981	1990	80	230	1994	Repl. w/ 1200'& 600' x 110'Ls & Repl/Rehab D
Ohio/Dashields	1981	1990	80	230	1994	Repl. w/ 1200'& 600' x 110'Ls & Rehab D
Ohio/Montomery	1981	1990	80	400	1994	Repl. w/ 1200'& 600' x 110'Ls & D
Ohio/McAlpine	1981	1989	83	250	1993	Repl. Aux L w/ 1200' x 110'L
Monongahela/Ls&Dam 2	1980	1990	75	55	1994	Repl. Aux L w/ 720' x 84'L & D
Monongahela/Ls&Dam 3	1980	1990	75	215	1994	Repl. w/ 2 720'x 84'Ls & D
Monongahela/Ls&Dam 4	1980	1990	75	125	1994	Repl. w/ 2 720'x 84'Ls & rehab D
Kanawha/Marmet	1982	1990	73	150	1994	Repl. 1 L w/ an 800' x 110'L
Tennessee/Kentucky	1975	1988	100	300	1993	Add a 1200' x 110'L
Tennessee/Chickamauga	1975	1992	39	120	1996	Add a 600' x 110'L
Tennessee/Watts Bar	1975	1992	39	120	1996	Add a 600' x 110'L
Tennessee/Ft. Loudon	1975	1992	39	100	1996	Add a 600' x 110'L

Table 4.7 Selected Measures to Increase System Capacity

	Annualized Cost ($000)	% Increase in Capacity (Typical range)	Cost ($000) for each % Increase	Safety Impact
SCHEDULING OF LOCK OPERATIONS - ASSISTANCE TO MULTICUT LOCKAGES				
Institute N-up/N-down Policy	0	13-16	0	HIGH
Institute Ready to Serve Policy	2092	33	63	LOW
Improve Tow Haulage Equipment	751	28	27	LOW
Increase Lock Staffing	52	1-2	30	HIGH
Institute Lock Scheduling	9	3	3	HIGH
IMPROVEMENTS TO APPROACHES				
Improvement to Approaches	116	3	39	HIGH
Provide Adjacent Mooring Cells	18	1-2	14	HIGH
Provide Funnel Shaped Guidewalls	U/A	U/A	U/A	HIGH
Install Wind Deflectors	2-20	0-.1	25-200	HIGH
TOW CONFIGURATION AND OPERATION				
Waterway Traffic Management	5-15	4	3	HIGH
Expand Fleeting Areas	200	U/A	U/A	MOD.
Bridge Maintenance and Operation	U/A	0-5	U/A	HIGH
LOCK OPERATING CONTROLS				
Modify Intake/Outlet Structures	70	4	16	MOD.
Install Trash Racks	29	4	7	MOD.
Expedite Operations in Ice Condition	23	2	12	MOD.
Install Air Bubbler System	38	0	-	HIGH
Install Floating Mooring Bitts	14	0	-	HIGH
Improve Lock Operating Equipment	191	0	-	HIGH
Install Gate Wickets	HIGH	0-3	-	LOW
Provide Operating Guides	MOD.	0-3	-	HIGH
Centralize Controls	104	1	104	HIGH
Provide Replaceable Fenders	LOW	0-1	-	LOW
Clear Vessel From Filling/ Emptying System	LOW	0	-	HIGH
STRUCTURAL ACTIONS				
Reduce Interference from Recreation	419	6	65	MOD.
Improve Use of Auxiliary Chamber	U/A	10-50	U/A	MOD.
Enlarge Lock to 1200 feet	4575	48	95	LOW
Physical Lock Replacement	8950	148	61	HIGH

U/A = Unavailable

Source: Upper Mississippi River Basin Commission, Comprehensive Master Plan for the Management of the Upper Mississippi River System, January 1982.

TABLE 4.8

CAPACITY EXPANSION MEASURES AND SCENARIOS

MEASURES	SCENARIOS* I	II	III	IV
GOVERNMENT				
Cost / % Increase in Capacity < $20.000				
Correct designed deficiencies	X	X		
Improve approaches	X	X		
Increase locks staffing		X		
Cost / % Increase in Capacity < $50.000				
Correct design deficiencies			X	X
Improve approaches			X	X
Increase lock staffing			X	X
Other				
Institute N-up/N-down where appropriate	X	X	X	X
Expedite operations in ice conditions			X	X
Recreational locks			X	X
Recreational lockage hours		X	X	X
Travelling kevel where appropriate as alternative to helper boats			X	X
Build additional locks where appropriate				X
INDUSTRY				
Mandate Bowboats for Large Tows		X		
Helper Boats Where Appropriate			X	X
Switchboats Where Appropriate			X	X

* Scenarios

I: No major changes, under current budgets, "with-out" condition.
II: Add system use of bowthrusters on multicut tows.
III: Minor structural changes plus full use of non-structural measures.
IV: Above measures plus additional chambers at selected sites to provide capacity sufficient for total unconstrained traffic projection.

SOURCE: Upper Mississippi River Basin Commission, Comprehensive Master Plan for the Management of the Upper Mississippi River System, January 1982

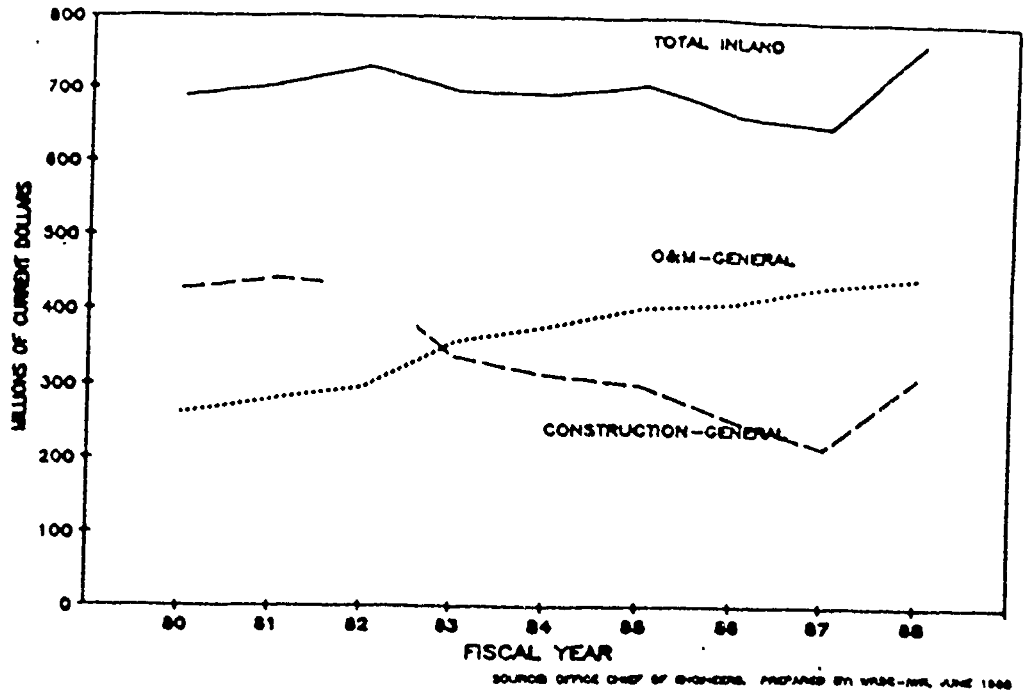


FIGURE 4.1

CORPS OF ENGINEERS
INLAND WATERWAYS APPROPRIATIONS
FY80–FY88 IN CURRENT DOLLARS

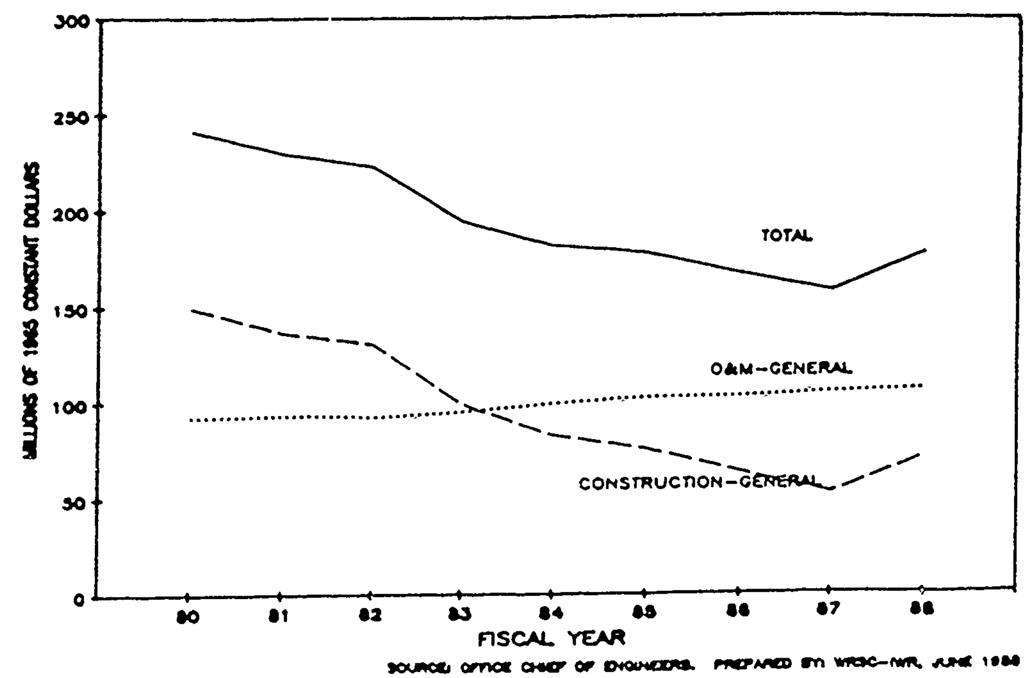


FIGURE 4.2 - continued

CORPS OF ENGINEERS
INLAND WATERWAYS APPROPRIATIONS
FY80–FY88 IN 1965 CONSTANT DOLLARS

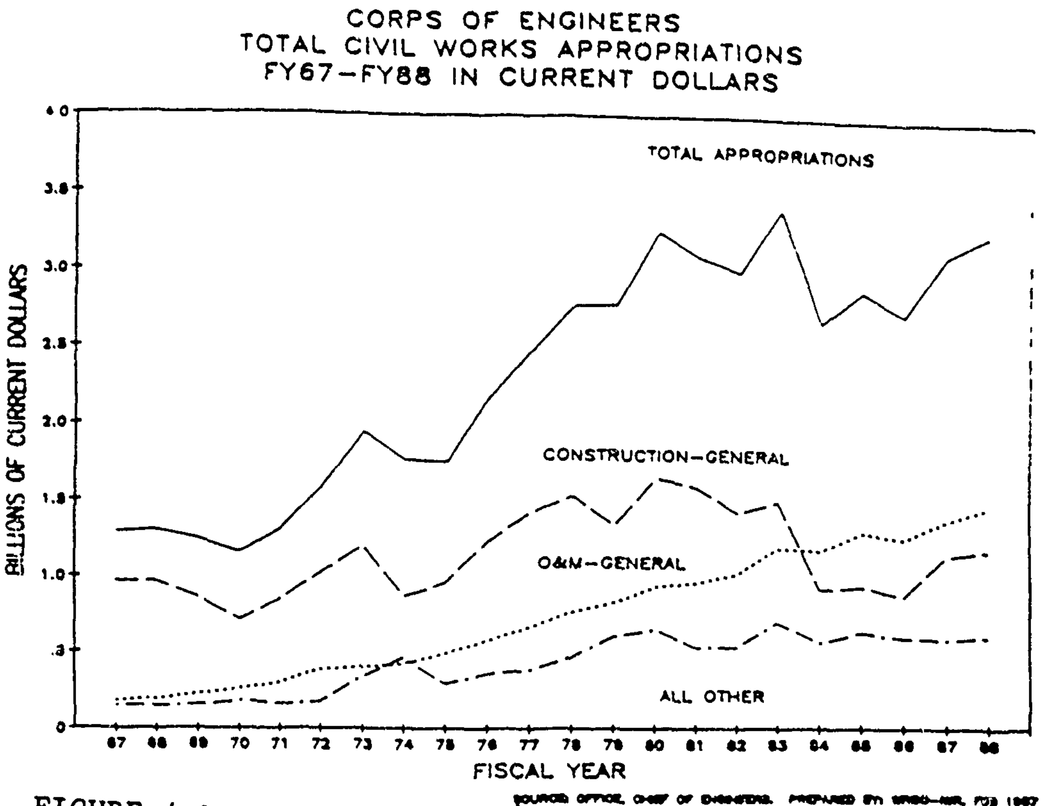


FIGURE 4.3

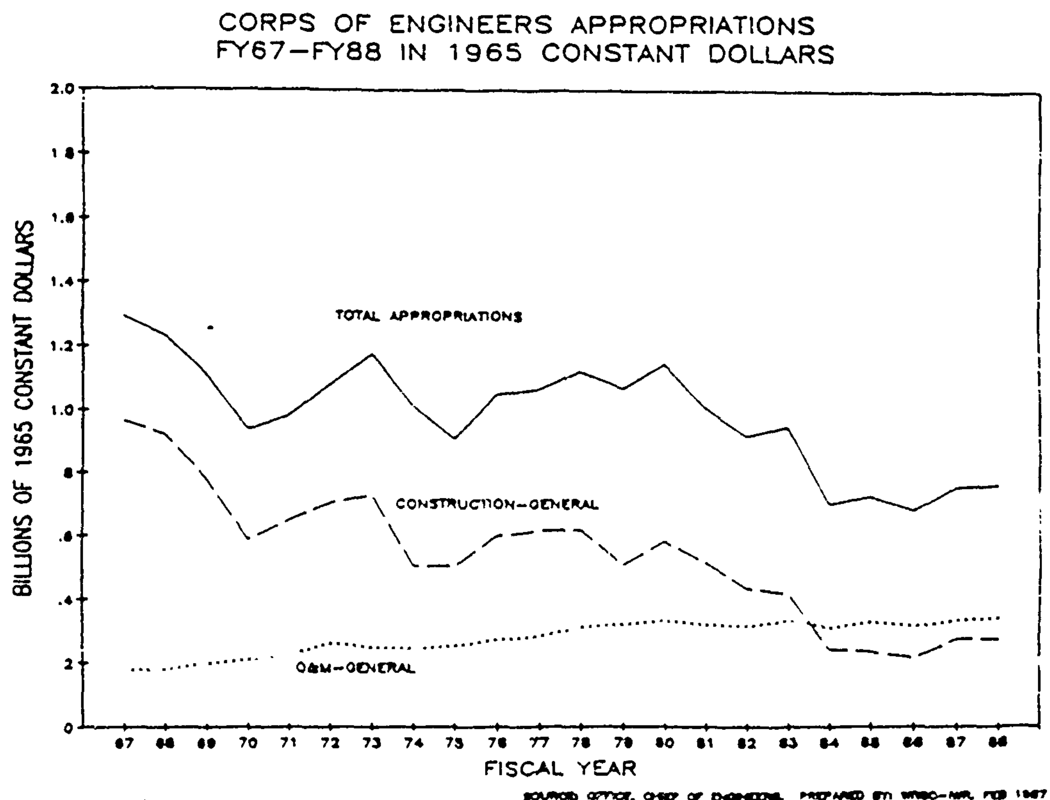


FIGURE 4.4

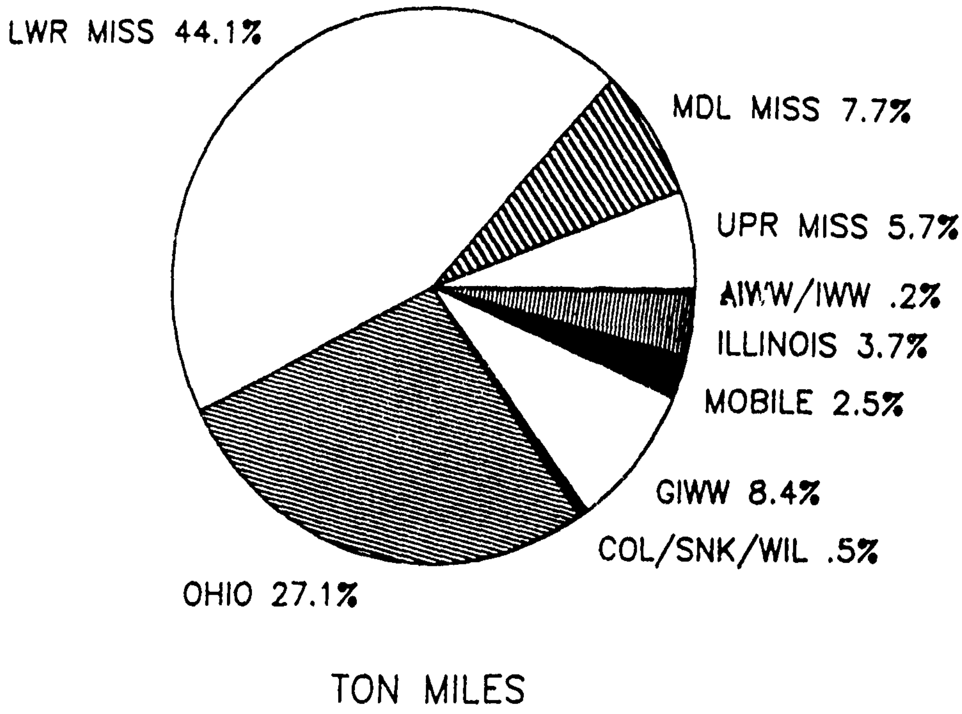


FIGURE 4.5

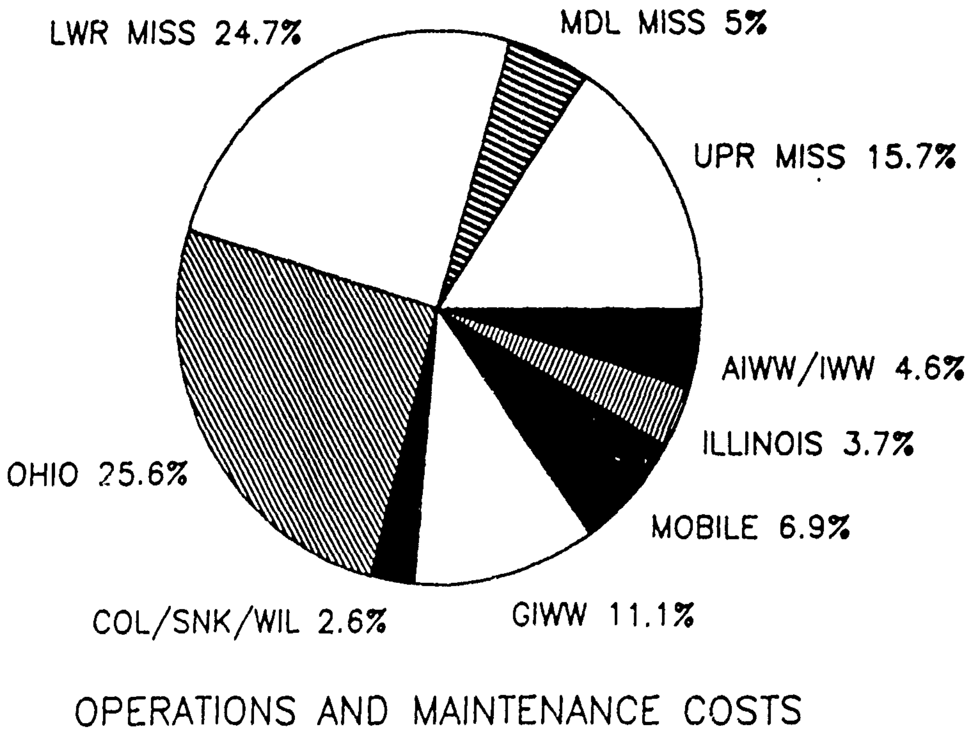


FIGURE 4.6

OPERATIONS AND MAINTENANCE COSTS PER TON MILE IN 1986
FOR INLAND WATERWAYS SUBJECT TO FUEL TAX

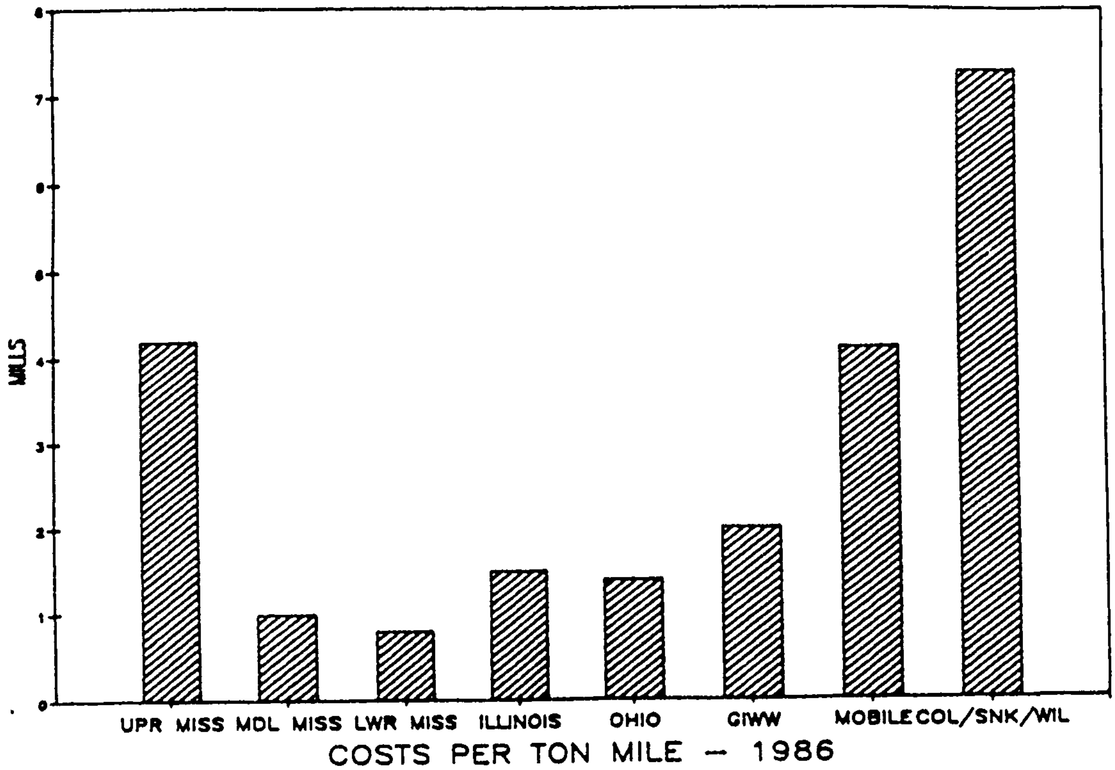


FIGURE 4.7

Chapter 5

STATUS OF THE INLAND WATERWAY TRUST FUND

DESCRIPTION

The Inland Waterways Trust Fund was authorized by the Inland Waterways Revenue Act of 1978 (PL 95-502) and amended by the Water Resources Development Act of 1986 (PL 99-662). These laws establish the Trust Fund, fuel taxes (ranging from $.10 per gallon of fuel before 1990 to $.20 per gallon after 1994) for tows operating on 27 waterways, and authorize appropriations from that fund. According to the Law, the fund will be available "for making construction and rehabilitation expenditures for navigation on the inland and coastal waterways..." To date, $99.8 million has been appropriated by Congress, $7.8 million in FY85, $26 million in FY87, and $66.2 million for FY88. Current expenditures are helping to fund the construction of five lock projects authorized by the Water Resources Development Act of 1986: Bonneville, Gallipolis, Lock and Dam 26 (2nd chamber), Oliver and Grays Landing.

RECEIPTS

Historical

Trust Fund fuel taxes were first collected in FY81 at the rate of $.04 per gallon. The first year's revenue was $21.2 million. Since waterway traffic has shown no sustained growth since 1981, annual fuel consumption has not increased. Taxes received have grown annually because of the increasing tax rate, not because of greater traffic levels. The balance in the Trust Fund grew rapidly in the early years because no expenditures were authorized by Congress until FY85. The fuel tax rate continued to increase, and interest earned on the Trust Fund balance increased as the balance increased. FY87 Trust Fund receipts were about $48.3 million. Interest on these receipts and the prior balance amounted to about $16.5 million.

Projected

Future receipts are linked to both the fuel consumption and the applicable tax rate. The forecast future receipts shown in Table 5.1 are based on an analysis using growth rates of 1.0 and 2.0 percent per year in traffic, which is assumed will be matched by a similar growth rate in fuel consumption (see Historic Trends and Projections). No inflation factor is applied to the calculation of receipts. The forecast future annual revenues without accrued interest, from FY89 to FY2000, grow from $48.3 million in FY87 to $111 million at a 1 percent growth rate or to $124 million if total traffic grows closer to 2 percent annually. These revenues will be supplemented by interest earned on the balance in the Trust Fund. The balance will be affected by the number and cost of projects funded in a particular fiscal year. The increase in receipts is heavily influenced, as in previous years, by the doubling of the tax from $.10 per gallon in FY89 to FY95's $.20 per gallon. The rate is scheduled to increase from $.10 to $.11 in 1990, $.13 in 1991, $.15 in 1992, $.17 in 1993, $.19 in 1994, and $.20 in 1995 and beyond.

Figure 5.1 shows the Trust Fund receipts, expenditures and balance through 2000. The graph incorporates a 1.5 percent growth rate in receipts (the middle range cited above and in Table 5.1) and 50 percent funding of eight authorized projects and one anticipated project on the fuel tax waterways. Receipts include accrued interest on the balance from each previous year.

There is considerable uncertainty in estimates relating to forecasts of ton-miles. The impacts of the fuel tax increases on waterway traffic share is not known with certainty and may have different impacts on the movement of different commodities. Other sources of uncertainty include the overall increase in grain exports, which are generally long-haul movements, and the application of fuel efficiency measures to vessels.

EXPENDITURES

As noted, outlays from the Trust Fund shown in Figure 5.1 are based on specific appropriations for eight authorized and one anticipated project on the fuel tax waterways. Table 5.2 shows the estimated cost of these projects and an estimate of the year in which construction could begin. Five of these projects actively drew from the Trust Fund in FY88. There are 12 additional projects currently under study which may be candidates for future funding as well. In addition, problems may emerge in the next few years at projects not yet under study, creating another wave of funding needs.

According to Section 102a of PL 99-662, one-half of construction costs "shall be paid only from amounts appropriated from the Inland Waterways Trust Fund." Table 5.3 displays start and estimated completion dates (some projects may be open to navigation earlier), total costs, and Trust Fund contributions for projects authorized to receive Trust Fund appropriations, plus Locks and Dams 52 and 53 replacement (Olmstead) for which the Chief of Engineers has recommended construction. The total expenditures of $2,626 million for these nine projects include an allowance for inflation during construction. Out-year projections are best estimates prepared by the Corps of Engineers and do not reflect fixed commitments or budget amounts for specific years. Looking at expenditures for these nine projects only, outlays are scheduled to peak in FY91 at $147 million and the Trust Fund balance dips accordingly.

Potential Projects Under Study

Several studies now underway in the Ohio River System are likely to result in favorable recommendations for construction of replacement projects. Table 34 shows the estimated cost of these projects and an estimate of the year in which construction could begin. These studies are targeted to the parts of the Ohio River System where age and capacity of locks and dams are likely to produce significant delays to waterway traffic, or where capacity constrains movement of potential traffic.

BALANCE

The balance in the Trust Fund was nearly $280 million at the end of FY87, the first year in which new projects were analyzed to draw from this fund. The nine scheduled projects will reduce the balance to approximately $200 million in the period FY91-FY93. If no other projects are started, the balance would increase to reflect revenues and interest on the Trust Fund balance, as shown in Figure 5.1.

SENSITIVITIES

However, there are other potential claims for funding from the Trust Fund. The WRDA of 1986 specifically authorizes, and the Corps' policy is, to recommend 50-50 funding for both rehabilitation and construction of inland navigation payments from the Trust Fund. At this time, there are 12 projects being rehabilitated and a potential for several additional projects by the year 2000. If the rehabilitation program is funded on a 50-50 basis from the Trust Fund, outlays from the Trust Fund would increase accordingly. This would reduce the Trust Fund

balance, but could be essentially accommodated from anticipated revenues coming into the Trust Fund. However, funding of the nine scheduled projects and the projected rehabilitation program could limit the capability to fund additional capacity related replacement needs for the 11,000 mile system. The 12 projects under study on the Ohio River System may cost about $4.7 billion (fully funded). The Trust Fund balance will not contain enough to fund 50 percent of the costs of these projects, if construction is started as soon as planning, engineering and design would permit. Other parts of the fuel tax segments appear at this time to warrant studies for consideration of replacement projects. These will add to the claims for funding.

One should not yet conclude that there is a funding crisis which cannot be solved. Either there will emerge convincing evidence that the fuel tax rate should be increased or that the budget priorities should stretch funds by delaying new starts, choosing not to fund lower priority projects and/or by increasing funding of low cost capacity increasing measures. These and many other alternatives will undoubtedly receive serious attention in planning studies and in the budget priority process.

CONCLUSION

The Trust Fund can provide for 50 percent funding of the nine projects now scheduled. Under projected growth in revenue, it could also fund the rehabilitation projects now underway and several new ones. It is also clear that several additional construction projects can exhaust the Trust Fund if scheduled as rapidly as current studies anticipate.

Therefore, an inland navigation budget priority process is unavoidable. There will undoubtedly be a significant budget constraint, surely from the Trust Fund and very likely from the General Tax Funds available to the U.S. Treasury. The budget priority system should be systemwide and based primarily on net system benefits available for each budget alternative, subject to budget constraints. This will inevitably lead to emphasis on lowering the capital intensity of many of the alternatives prepared for funding. Smaller scale investments for measures with high immediate payoff will attract funding priorities.

Table 5.1

FUTURE INLAND WATERWAY TRUST FUND FUEL TAX RECEIPTS

Fiscal Year	Tax Rate (cents per gallon)	Receipts Under Alternative Growth Rates of Fuel Consumed[1] (millions of dollars) 1%	2%	Difference
1987	10	$ 48	$ 48	$ 0
1990	11	55	56	1
1995	20	105	113	8
2000	20	111	124	13
2005	20	116	137	21
Cumulative Total 1981-2005:		1946	2117	171

1 Based on forecasts prepared by the Corps Institute for Water Resources.

TABLE 5.2

KNOWN POTENTIAL EXPENDITURES FROM TRUST FUND
FY87 - FY2002

Waterway	Authorized Projects	Dates Start[1]	Dates Complete[2]	Costs[3] Millions of Oct 86 $ Total	Costs[3] Millions of Oct 86 $ Trust Fund
Columbia R.	Bonneville L., OR & WA	86	92	200	100
Ohio R.	Gallipolis L&D, WV & OH	86	95	335	167
Mid-Miss. R.	L&D 26, 2nd L., IL & MO	86	91	214	107
Black-Warrior R.	Oliver L&D, AL	86	91	122	61
Monongahela R.	Grays Ldg, L&D 7, PA	86	95	146	73
Monongahela R.	Pt. Marion, L&D 8, PA	86	93	94	47
Kanawha R.	Winfield L&D, WV	87	97	190	95
GIWW	MRGO, Inner Hbr, LA	86	2000	580	193[4]
Ohio R.	Olmstead L&D, IL & KY*	86	2000	745	373
Total				2626	1216

* Not authorized; Chief's report recommends construction.
1 Includes PED (Planning, Engineering and Design) start date.
2 Or earliest date open to navigation.
3 Cost estimates include allowance for inflation during construction.
4 Allocation tentative, cost sharing yet to be determined.

FOR ILLUSTRATION ONLY

TABLE 5.3

INLAND WATERWAYS TRUST FUND

SCHEDULE OF EXPENDITURES BY PROJECT AND YEAR
FOR 9 BUDGETED PROJECTS AND 12
POTENTIAL PROJECTS UNDER ACTIVE STUDY

($1000)

PROJECT	SOURCE		THRU FY 1987	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY2007	FY2008	FY2009	FY2010	TOTAL W/ INFLATN	TOTAL W/O INFLATN	PRICE LEVEL
BONNEVILLE NAV. LOCK, OR & WA	FED	0	14,945	19,007	21,000	21,000	22,000	8,048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106,000	101,000	OCT 87
	INWTF	0	14,959	18,993	21,000	21,000	22,000	8,048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106,000	101,000	
	TOTAL	0	29,904	38,000	42,000	42,000	44,000	16,096	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	212,000	202,000	
GALLIPOLIS L&D, WV & OH	FED	0	4,375	30,438	30,000	36,600	32,800	7,700	18,000	8,087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168,000	157,000	OCT 87
	INWTF	0	4,250	30,562	30,000	36,600	32,800	7,700	18,000	8,088	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168,000	157,000	
	TOTAL	0	8,625	61,000	60,000	73,200	65,600	15,400	36,000	16,175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	336,000	314,000	
L&D 26, 2ND LOCK, IL & MO	FED	0	4,268	1,800	6,500	33,000	27,000	33,932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106,500	97,500	OCT 87
	INWTF	0	4,268	1,800	6,500	33,000	27,000	33,932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106,500	97,500	
	TOTAL	0	8,536	3,600	13,000	66,000	54,000	67,864	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	213,000	195,000	
W.B. OLIVER L&D REPLACE., AL	FED	0	10,181	9,900	15,500	16,000	6,000	2,919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60,500	58,500	OCT 87
	INWTF	0	10,181	9,900	15,500	16,000	6,000	2,919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60,500	58,500	
	TOTAL	0	20,362	19,800	31,000	32,000	12,000	5,838	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121,000	117,000	
GRAYS LANDING, L&D #7, PA MONONGAHELA	FED	0	3,860	1,130	7,100	12,300	15,450	15,000	8,700	10,000	8,960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82,500	72,500	OCT 87
	INWTF	0	0	4,990	7,100	12,300	15,450	15,000	8,700	10,000	8,960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82,500	72,500	
	TOTAL	0	3,860	6,120	14,200	24,600	30,900	30,000	17,400	20,000	17,920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	165,000	145,000	
POINT MARION, L&D #8, PA MONONGAHELA	FED	0	1,062	990	374	7,700	12,400	12,400	11,974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46,900	41,450	OCT 87
	INWTF	0	0	0	2,426	7,700	12,400	12,400	11,974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46,900	41,450	
	TOTAL	0	1,062	990	2,800	15,400	24,800	24,800	23,948	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93,800	82,900	
WINFIELD L&D, WV	FED	0	1,185	2,005	1,655	3,000	1,100	16,400	25,000	25,000	12,400	1,255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89,000	76,500	OCT 87
	INWTF	0	0	0	4,845	3,000	1,100	16,400	25,000	25,000	12,400	1,255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89,000	76,500	
	TOTAL	0	1,185	2,005	6,500	6,000	2,200	32,800	50,000	50,000	24,800	2,510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	178,000	153,000	
MISS RIV GULF OUTLET, LA (Costs tent pending reeval of scope & establishment of cost-sharing methodology)	FED	0	552	850	500	600	2,000	2,000	14,500	40,000	50,000	70,000	70,000	70,000	50,000	15,798	0	0	0	0	0	0	0	0	0	0	386,800	328,000	OCT 87
	INWTF	0	0	0	0	0	0	0	10,501	20,000	25,000	35,000	35,000	35,000	25,000	7,899	0	0	0	0	0	0	0	0	0	0	193,400	164,000	
	TOTAL	0	552	850	500	600	2,000	2,000	25,001	60,000	75,000	105,000	105,000	105,000	75,000	23,697	0	0	0	0	0	0	0	0	0	0	580,200	492,000	
LOCKS & DAMS 52 & 53, IL & KY (REPLACEMENT)	FED	0	2,875	2,500	2,500	3,000	5,000	5,064	19,530	50,000	65,000	65,000	62,500	57,500	57,500	40,000	27,500	19,531	0	0	0	0	0	0	0	0	485,000	387,500	OCT 87
	INWTF	0	0	0	0	0	0	0	40,470	50,000	65,000	65,000	62,500	57,500	57,500	40,000	27,500	19,530	0	0	0	0	0	0	0	0	485,000	387,500	
	TOTAL	0	2,875	2,500	2,500	3,000	5,000	5,064	60,000	100,000	130,000	130,000	125,000	115,000	115,000	80,000	55,000	39,061	0	0	0	0	0	0	0	0	970,000	775,000	
GRAND TOTAL	FED	0	43,303	68,620	85,129	133,200	123,750	103,463	97,704	133,087	136,360	136,255	132,500	127,500	107,500	55,798	27,500	19,531	0	0	0	0	0	0	0	0	1,531,200	1,319,950	
	INWTF	0	33,658	66,245	87,371	129,600	116,750	96,399	114,645	113,088	111,360	101,255	97,500	92,500	82,500	47,899	27,500	19,530	0	0	0	0	0	0	0	0	1,337,800	1,155,950	
	TOTAL	0	76,961	134,865	172,500	262,800	240,500	199,862	212,349	246,175	247,720	237,510	230,000	220,000	190,000	103,697	55,000	39,061	0	0	0	0	0	0	0	0	2,869,000	2,475,900	

NEW CONSTRUCTION PROJECTS (BASED ON ACTIVE STUDIES) DRAWING FROM INLAND WATERWAYS TRUST FUND
ANALYSIS BASED ON CALCULATIONS WITH AND WITHOUT INFLATION

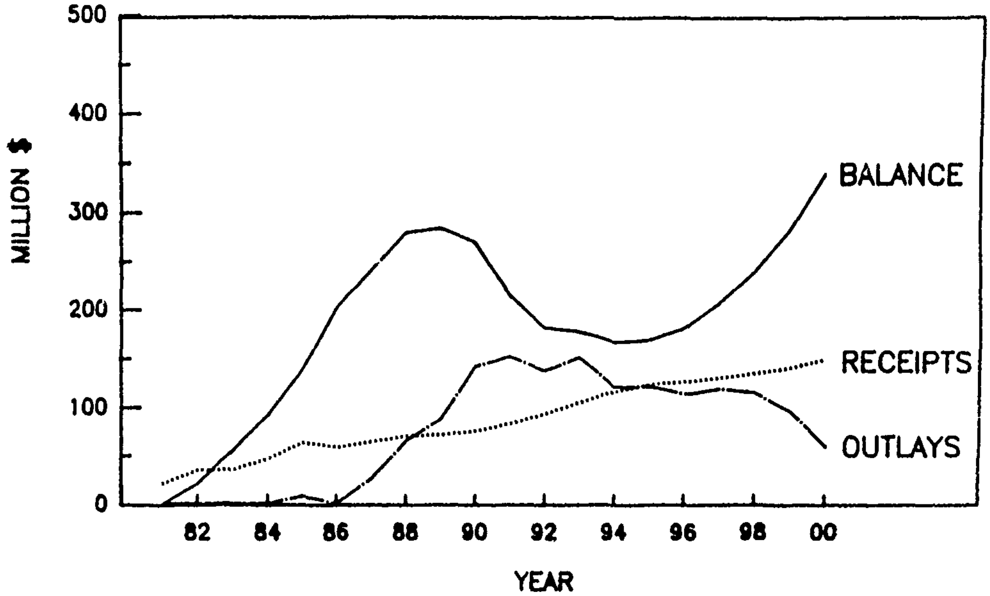
PROJECT	SOURCE		THRU FY 1987	FY 1988	FY 1989	THRU FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY2007	FY2008	FY2009	TOTAL W/ INFL-TN	TOTAL W/O INFLATN
POTENTIAL NEW CONSTRUCTION CURRENTLY UNDER STUDY																											
MONONGAHELA L&D 2, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	10,711	10,711	10,711	10,711	10,711	0	0	0	0	0	0	53,556	27,500
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	10,711	10,711	10,711	10,711	10,711	0	0	0	0	0	0	53,556	27,500
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	21,422	21,422	21,422	21,422	21,422	0	0	0	0	0	0	107,112	55,000
MONONGAHELA L&D 3, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,965	43,965	43,965	43,965	43,965	0	0	0	0	0	219,824	107,500
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43,965	43,965	43,965	43,965	43,965	0	0	0	0	0	219,824	107,500
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87,930	87,930	87,930	87,930	87,930	0	0	0	0	0	439,648	215,000
MONONGAHELA L&D 4, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,839	26,839	26,839	26,839	26,839	0	0	0	0	134,195	62,500
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,839	26,839	26,839	26,839	26,839	0	0	0	0	134,195	62,500
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53,678	53,678	53,678	53,678	53,678	0	0	0	0	268,390	125,000
MARMET L&D, WV	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,673	30,673	30,673	30,673	30,673	0	0	0	0	0	153,366	75,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,673	30,673	30,673	30,673	30,673	0	0	0	0	0	153,366	75,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61,346	61,346	61,346	61,346	61,346	0	0	0	0	0	306,731	150,000
EMSWORTH L&D, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	44,792	44,792	44,792	44,792	44,792	0	0	0	0	0	0	223,962	115,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	44,792	44,792	44,792	44,792	44,792	0	0	0	0	0	0	223,962	115,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	89,585	89,585	89,585	89,585	89,585	0	0	0	0	0	0	447,923	230,000
DASHIELDS L&D, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47,032	47,032	47,032	47,032	47,032	0	0	0	0	0	235,161	115,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47,032	47,032	47,032	47,032	47,032	0	0	0	0	0	235,161	115,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94,064	94,064	94,064	94,064	94,064	0	0	0	0	0	470,321	230,000
MONTGOMERY L&D, PA	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85,885	85,885	85,885	85,885	85,885	0	0	0	0	429,424	200,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85,885	85,885	85,885	85,885	85,885	0	0	0	0	429,424	200,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171,769	171,769	171,769	171,769	171,769	0	0	0	0	858,847	400,000
McALPINE L&D, IN & KY	FED	0	0	0	0	0	0	0	0	0	0	0	0	46,369	46,369	46,369	46,369	46,369	0	0	0	0	0	0	0	231,845	125,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	46,369	46,369	46,369	46,369	46,369	0	0	0	0	0	0	0	231,845	125,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	92,738	92,738	92,738	92,738	92,738	0	0	0	0	0	0	0	463,690	250,000
KENTUCKY L&D, KY	FED	0	0	0	0	0	0	0	0	0	48,066	48,066	48,066	48,066	48,066	0	0	0	0	0	0	0	0	0	0	240,332	150,000
	IWTF	0	0	0	0	0	0	0	0	0	48,066	48,066	48,066	48,066	48,066	0	0	0	0	0	0	0	0	0	0	240,332	150,000
	TOTAL	0	0	0	0	0	0	0	0	0	96,133	96,133	96,133	96,133	96,133	0	0	0	0	0	0	0	0	0	0	480,664	300,000
CHICKAMAUGA L&D, TN	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,318	31,318	31,318	31,318	31,318	156,590	60,000
	IWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,318	31,318	31,318	31,318	31,318	156,590	60,000

NEW CONSTRUCTION PROJECTS (BASED ON ACTIVE STUDIES) DRAWING FROM INLAND WATERWAYS TRUST FUND
ANALYSIS BASED ON CALCULATIONS WITH AND WITHOUT INFLATION

PROJECT	SOURCE		THRU FY 1987	FY 1988	FY 1989	THRU FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY2007	FY2008	FY2009	TOTAL W/ INFLATN	TOTAL W/O INFLATN
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62,636	62,636	62,636	62,636	62,636	313,180	120,000
WATTS BAR L&D, TN	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,318	31,318	31,318	31,318	31,318	156,590	60,000
	INWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,318	31,319	31,319	31,318	31,318	156,590	60,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62,636	62,636	62,636	62,636	62,636	313,180	120,000
FT LOUDON L&D, TN	FED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,098	26,098	26,098	26,098	26,098	130,492	50,000
	INWTF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,098	26,098	26,098	26,098	26,099	130,492	50,000
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52,197	52,197	52,197	52,197	52,197	260,983	100,000
SUBTOTAL--PROJECTS UNDER STUDY	FED	0	0	0	0	0	0	0	0	0	48,066	48,066	48,066	94,435	149,939	223,543	336,266	336,266	289,897	234,394	201,458	88,734	88,734	88,734	88,734	2,365,336	1,147,500
	INWTF	0	0	0	0	0	0	0	0	0	48,066	48,066	48,066	94,435	149,939	223,543	336,266	336,266	289,897	234,394	201,458	88,734	88,734	88,734	88,734	2,365,336	1,147,500
	TOTAL	0	0	0	0	0	0	0	0	0	96,133	96,133	96,133	188,871	299,878	447,085	672,533	672,533	579,795	468,787	402,916	177,469	177,469	177,469	177,469	4,730,672	2,295,000

FIGURE 5.1

INLAND WATERWAYS TRUST FUND
RECEIPTS, OUTLAYS & BALANCE FOR NINE PROJECTS



SOURCE: CECWB, IWR, JUNE 88.

ACKNOWLEDGEMENTS

The following people have contributed significantly to the creation of this document:

Antle, Lloyd G. - directed the preparation of the Review and co-authored the Overview. He Received a PhD in economics from the University of Cincinnati. He has been with the Corps for 24 years, and Chief of the Navigation Division of the IWR since 1984. Prior to that assignment, he was Chief of the Special Studies and Research Divisions at IWR.

Clark, Morris William - co-authored the Physical System and Program Review Sections. He is presently a candidate for a DBA at Nova University in Ft. Lauderdale, FL. He has a masters in economics from NYU. He has been an economist in the Navigation Division of IWR for the past 8 years and previously was with the U.S. Water Resources Council, HUD and OMB as an economist.

Dietz, Arlene L. - has been a prime mover in preparing the Scope of Work, the methodology and review of the Waterway Review draft. Mrs. Dietz, who has recently transferred to become the Chief of the WRSC Navigation Data Center, has a masters degree in economics from the University of Colorado. She has completed 20 years of service with the Corps of Engineers, including 7 years as Chief of the economics section of the Planning Branch, Chicago District. At IWR she was study manager of the National Waterways Study and a senior Navigation Specialist.

Grier, David V. - co-authored the section on Waterway Traffic and was the principal author of the Status of the Inland Waterways Trust Fund. He has an M.A. in geography from Florida State University. He has been with IWR for the last 8 years specializing in transportation geography.

Hawnn, Arthur F. - was the major author and team leader for Appendix A. He received his PhD in Civil Engineering/Industrial Engineering at the University of Wisconsin. He has been with the Corps for 14 years, the last 9 years at IWR's Navigation Division, 5 years at the Chief of Engineers Planning Division and prior to his Corps experience he served in private industry as a consultant and taught at the University of Wisconsin and Ohio State University.

Lane, John M. - co-authored the Physical System section. He is an M.A. candidate at the University of Arizona in geography. He has been with the Corps of Engineers 17 years, the last 7 of which he's been with the Navigation Division of IWR. Prior to that he was with the Systems Analysis Branch at the Office of the Chief of Engineers.

Robinson, Dennis - co-authored the Program Review section. He has a Ph.D. in economics from George Washington University. He has been with the Navigation Division of IWR for the last 2 years. Previously he was with the Corps at the Construction Engineering Research Laboratory for 5 years. He also served with the U.S. Government at the Environmental Protection Agency and Bureau of Economic Analysis at the Department of Commerce. Bill Clark co-authored this chapter. His background is mentioned above for the physical system chapter.

Sharp, Frank - was responsible for editing the Review. He is a Ph.D. candidate at St. Louis University. He has been with the Corps 21 years, the last 8 of which were spent at IWR. Previous to that time he was the Chief of the Systems Analysis Branch in the Planning Division at the Office, Chief of Engineers.

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Westphal, Joseph - contributed toward the Program Review section and authored Appendix B. He has a Ph.D. in Political Science from the University of Missouri. He is presently participating in the intergovernmental personnel program at IWR while being professor at Oklahoma State University.

Yoe, Charles - authored the section on Performance of Locks. He received his Ph.D. in Agricultural and Resource Economics from the University of Maryland. For the last year he has been with the Navigation Division of IWR. Before that he was on the economics faculty at the University of Maryland and earlier he served as a regional economist at the Baltimore District of the Corps of Engineers.

Schultz, Richard - edited the section on Performance of Locks when Charles Yoe returned to university teaching. He also made a major contribution to the completion of the Overview section. He has a BS in Economics from the Wharton School, University of Pennsylvania. His employment prior to the Corps was in shipping and seaport administration.

Several members of the Corps field organization made significant contributions during the revision of the draft report into this final report.

Jesse McDonald, from the Lower Mississippi Valley Division, Larry Prather, from the Ohio River Division, Paul Soyke, Chief of the Rock Island District Economics Branch, Tom Raster, from the St. Paul District, helped bring the document up to date, both in data and in printing a clear and knowledgeable assessment of the urgent problems in each Divisions navigation program.

Chip Smith, an environmental planner from the Rock Island District collaborated with Joe Westphal to elaborate the Corps commitment and capability to build and operate a first class waterway system which consistently meets or exceeds the many legal requirements of various National Environmental Legislations.

Others who contributed a great deal to the report were Jim Gould, Shilpa Patel, Margaruiette Polk, and Howard Olson. Shandra Myers and Jan Peterson performed the difficult job of organizing and typing the many drafts. Most of the data presented in this document was developed by Corps personnel in the districts, divisions, and Office, Chief of Engineers.

THE 1988 INLAND WATERWAYS REVIEW

APPENDIX A

DESCRIPTION OF WATERWAY SEGMENTS

NOVEMBER 1988

INSTITUTE FOR WATER RESOURCES
ARMY CORPS OF ENGINEERS
FORT BELVOIR, VA 22060
(202) 355-224C

THE 1988 INLAND WATERWAYS REVIEW

APPENDIX A - DESCRIPTION OF WATERWAY SEGMENTS

TABLE OF CONTENTS

List of Tables

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

List of Figures

List of Figures (Continued)

List of Figures (Continued)

I. INTRODUCTION

The purpose of this appendix is to describe and present the text and data related to the nine inland waterway segments in terms of the following six elements:

a. Physical Characteristics of Channels and Locks

b. Performance Characteristics of Locks

c. Shallow Draft Waterway Traffic Projection Methodology

d. Operations and Maintenance Costs

e. Program Status

f. Lock Capacity Characteristics

This information serves as the major input to the main report "Status of the Inland Waterways," submitted to the Assistant Secretary of the Army (Civil Works), the Chief of Engineers, and the Inland Waterways Users Board (IWUB). The data and analysis herein are not final, but are subject to revision as more and better information becomes available.

The text and data are organized for the nine inland waterway segments, delineated in the following Table A-1 and Figure A-1. Definitions of terms and highlights (summary analysis) of nine segments are given below.

II. DEFINITIONS OF TERMS

The definitions of terms and features common to all nine segments are presented below for the six elements, rather than repeating them in each of the nine segment description.

1. Physical Characteristics of Channels and Locks

a. This element describes the basic characteristics of the waterway system's channels and locks. The channel characteristics include length, width, and depth as well as special considerations such as open river conditions, restricted navigation, authorized but not constructed sections, and whether a segment includes a significant waterway that is not subject to the fuel tax. The lock characteristics include length and width of chambers, presence of auxiliary locks, lift, and age.

b. The source for the table on "Physical Characteristics of Locks" is the report entitled Annual Report FY 85 of the Chief of Engineers on Civil

TABLE A-1

WATERWAY SEGMENT DESIGNATIONS

SEG NO.	SEGMENT NAME	WATERWAYS COVERED UNDER PL 95-502 AND PL 99-662
1.	UPPER MISSISSIPPI	Upper Miss. Main Stem: Minneapolis-Mouth Missouri
2.	MIDDLE MISSISSIPPI	Upper Miss. Main Stem: Mouth Missouri -Mouth Ohio Missouri Kaskaskia
3.	LOWER MISSISSIPPI	Lower Miss. Main Stem: Mouth Ohio-Baton Rouge McClellen-Kerr Arkansas R. System White Ouachita-Black Red Atchafalaya
4.	ILLINOIS WW	Illinois Waterway
5.	OHIO RIVER SYSTEM	Ohio River-Main Stem Tennessee Cumberland Green & Barren Kentucky Kanawha Allegheny Monongahela
6.	GULF INTRACOASTAL WW	GIWW Main Stem: St. Marks-Brownsville Apalachicola-Chattahoochee-Flint Pearl
7.	MOBILE R. & TRIBS	Alabama-Coosa Black Warrior-Tombigbee-Mobile Tennessee-Tombigbee Waterway
8.	ATLANTIC INTRACOASTAL WW	AIWW: Norfolk-Jacksonville (2 routes) IWW: Jacksonville-Miami
9.	COLUMBIA-SNAKE WW	Columbia (Above The Dalles) Snake Willamette (Above Portland)

FIGURE A-1

INLAND WATERWAY SEGMENTS

Works Activities, Appendix C: Navigation Locks and Dams Operable September 30, 1985.

2. Performance Characteristics of Locks

a. This element describes the overall performance of individual locks functioning as components of the inland waterway system in terms of the selected performance characteristics.

b. The source of information in this paragraph is the Lock Performance Monitoring System (PMS), Corps of Engineers, 1986. The definitions of relevant terms derived from the PMS User's Manual for Data Analysis, Nov.,1985 are as follows:

Average Delay (hrs) = (Wait + Stall) / # vsls

Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls

Average Processing Time (hrs) = Wait + App + Ent + Chbr + Ex + Trn + Stl / # vsl

Total Delay Time (hrs) = Wait + Stall (commercial vsls only)

Stall Time 1 (hrs) = Debris in lock recesses or in lock chamber + Lock hardware + Lock staff occupied with other duties + Testing or maintaining lock or lock equipment

Number of Stall 1 = Same as Stall Time 1

Stall Time 2 (hrs) = Fog + Rain + Sleet or Hail + Snow + Wind + Ice + River current or outdraft + Condition + Flood

Number of Stall 2 = Same as Stall Time 2

Stall Time 3 (hrs) = Interference by other vessels + Tow Malfunction or breakdown + Tow staff occupied with other duties + Tow detained by Coast Guard and/or Corps + Collision of accident + Vehicular or railway bridge delay + Other

Number of Stall 3 = Same as Stall Time 3

Total Stall Time (hrs) = Stall Time 1 + 2 + 3

Total Number of Stall = Number of Stalls 1 + 2 + 3

Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year

Total Tonnage = See PMS 22 in the PMS User's Manual for Data Analysis (85-UM-2)

Total Upbound Tonnage = See PMS 22 in the PMS User's Manual for Data Analysis (85-UM-2)

Total Downbound Tonnage = See PMS 22 in the PMS User's Manual for Data Analysis (85-UM-2)

Total Number of Tows = See PMS 5 in the PMS User's Manual for Data Analysis (85-UM-2)

Total Number of Upbound Tows = See PMS 5 in the PMS User's Manual for Data Analysis (85-UM-2)

Total Number of Downbound Tows = See PMS 5 in the PMS User's Manual for Data Analysis (85-UM-2)

Average Tons per Tow = Tons / # Tows with tonnage

Average Barges per Tow = Barges / # Tows with Barges

3. Shallow Draft Waterway Traffic Projection Methodology

The following section describes the data collected and the methodology used to project inland and intracoastal waterway traffic through 2000. The projections should be considered preliminary and subject to change.

The waterborne commodity projections have been made using existing forecasting services, data and indicators. Historic data was collected by commodity and waterway using available information from the Waterborne Commerce Statistics Center. Traffic for 1965 through 1986 was tabulated and aggregated by commodity group and waterway. Ten aggregated commodity groups were chosen:

1. Farm Products
2. Metallic Ores, Products and Scrap
3. Coal
4. Crude Petroleum
5. Nonmetallic Minerals/Products
6. Forest Products
7. Industrial Chemicals
8. Agricultural Chemicals
9. Petroleum Products
10. All Other

Data for these commodity groups were aggregated at the national level and for individual waterways. The waterways for which historic and projected traffic have been prepared include to date:

1. Upper Mississippi
2. Middle Mississippi
3. Missouri
4. Lower Mississippi
5. Arkansas
6. Illinois
7. Ohio
8. Monongahela
9. Kanawha
10. Cumberland
11. Tennessee
12. Gulf Intracoastal Waterway
13. Black Warrior-Tombigbee WW
14. Atlantic Intracoastal Waterway
15. Columbia

In order to project traffic by commodity, growth indicators were sought from a variety of sources. The major forecasting services--Data Resources (DRI) and WEFA Group (formerly Wharton and Chase Econometrics)--were utilized to a considerable extent. IWR contracts with DRI's Transportation Service and receives quarterly and annual reports. In addition, IWR contracted with DRI to prepare a special analysis of the waterway system. This was the only source of information which had projections tailored specifically to the waterway system. Other sources of information were used to provide growth indicators for certain industries or sectors of the economy which IWR then adapted into waterway projections using historic relationships. Publications from WEFA Group provided long-term forecasts for major sectors of the economy, plus more detailed analysis of agriculture, energy, fertilizer and steel. IWR also drew upon published reports of the Department of Energy (DOE), the Department of Agriculture (USDA), and the Fertilizer Institute.

Additionally, historic data from 1965-1986 by commodity group for total U.S. Inland Waterway Traffic and total movements by waterway segment were analyzed and used to develop projections for those areas where a correlation between time and tonnage could be identified.

The approach taken and the sources utilized varied by commodity. Generally, several sources were used to develop an envelope of low and high projections starting from a base year. Base years were identified and tonnage estimates made in a manner that would generate the most realistic near-term projections for 1990. The base year tonnages were developed from trend lines, weighted averages, straight averages, and specific years. All base year tonnages were designated as 1986 for projection purposes. The growth rates for each commodity and the sources from which these rates were adapted are identified below:

COMMODITY/SCENARIO		GROWTH RATE/PERIOD/SOURCE	TYPE OF INDICATOR
FARM PRODUCTS			
LOW:	3.4% 86-89.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	1.5% 90-2000.	DRI Industry Review Fall 87	(Food grain productivity.)
MED:	3.4% 86-90.	DRI, Waterway Outlook, Dec. 87.	(Waterway traffic.)
	2.3% 91-95.	Same source.	
	1.9% 96-2000.	Same source.	
HIGH:	4.6% 86-90.	WEFA Group, US Food & Ag. Long Term Forecast and Analysis, No. 2 1987.	(Ratio of waterway traffic to projected exports of wheat, corn & soybeans.)
	2.6% 91-2000.	Same source.	
METALLIC ORES, PRODUCTS & SCRAP			
LOW:	-0.3% 86-90.	WEFA Group, Global Steel Analysis, End 87 Update.	(Ratio US steel production to waterway metal traffic.)
	-0.4% 91-2000.	Same source.	

MED:	1.5% 86-90.	DRI, Waterway Outlook, Dec. 87.	(Waterway traffic.)
	-0.7% 91-95.	Same source.	
	-1.1% 96-2000.	Same source.	
HIGH:	4.7% 86-90.	DRI Long Term Review Winter 87/88.	(Growth rate for primary metals industry.)
	-0.2% 91-95.	Same source.	
	0.0% 96-2000.	Same source.	

COAL

LOW:	1.9% 86-2000.	DOE Annual Energy Outlook March 88. Low case.	(Ratio coal production to waterway traffic and assumptions on waterway share.)
MED:	2.5% 86-2000.	DOE, Annual Energy Outlook March 88.	(Ratio coal production to waterway traffic and assumptions on waterway traffic share.)
HIGH:	3.2% 86-2000.	DOE, Annual Energy Outlook March 88. High Case.	(Ratio coal production to waterway traffic and assumption on waterway share.)

CRUDE PETROLEUM

LOW:	-4.0% 86-95.	DOE, Annual Energy Outlook March 88. High Case.	(Ratio US oil production to waterway traffic.)
	-1.8% 96-2000.	Same source.	
MED:	-3.0% 86-90.	DOE Annual Energy Outlook March 88. Low Case.	(Ratio US oil production to waterway traffic.)
	-2.0% 91-95.	Same source.	
	-0.6% 96-2000.	Same source.	
HIGH:	-1.4% 86-2000.	DRI Waterway Outlook Dec 87	(Waterway traffic.)

NONMETALLIC MINERALS AND PRODUCTS

LOW:	-1.6% 86-91.	DRI, Waterborne Traffic Outlook, Dec. 86.	(Waterway traffic.)
	0.3% 92-2000.	DRI, Interindustry Review Spring 86.	(Growth rate for public works projects.)
MED:	0.5% 86-2000.	IWR, National Waterways Study, 1983, Medium Case.	(Waterway traffic.)
HIGH:	1.0% 86-90.	IWR, National Waterways Study, 1983, High case.	(Waterway traffic.)
	0.5% 91-2000.	Same source.	

FOREST PRODUCTS

LOW:	1.9% 86-90.	DRI, US Long Term Review Winter 87/88.	(Growth index for lumber and wood products.)
	0.8% 91-95.	Same source.	

	1.2% 96-2000.	Same source.	
MED:	2.7% 86-92.	WEFA Group, US Long Term Economic Outlook, 1st Qtr 88.	(Growth index for logging and lumber.)
	1.3% 93-2000.	Same source.	
HIGH:	6.3% 86-90.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	0.3% 91-95.	Same source.	
	1.1% 96-2000.	Same source.	

INDUSTRIAL CHEMICALS

LOW:	1.7% 86-2000.	DRI Waterborne Traffic Outlook, Dec. 86.	(Waterway traffic.)
MED:	2.8% 86-2000.	IWR, National Waterways Study, 1983.	(Waterway traffic.)
HIGH:	3.5% 86-2000.	DRI, Interindustry Review Spring 86.	(Growth index for chemical industry.)

AGRICULTURAL CHEMICALS

LOW:	0.3% 86-90.	WEFA Group, US & World Fertilizer Service, 1987.	(Growth rate for farm fertilizer use.)
	2.8% 91-95.	Same source.	
	2.1% 96-2000.	Same source.	
MED:	1.5% 86-90.	Fertilizer Institute, Long Range Future of North American Fertilizer, May 1987.	(Growth rate for fertilizer consumption.)
	3.0% 91-2000.	Same source.	
HIGH:	4.2% 86-92.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	3.1% 93-2000.	Same source.	

PETROLEUM PRODUCTS

LOW:	0.7% 86-90.	DOE Annual Energy Outlook, March 88. Low Case.	(Ratio of US consumption to waterway traffic.)
	0.1% 91-2000.	Same source.	
MED:	2.0% 86-90.	DRI Waterway Outlook, Dec 87.	(Waterway traffic.)
	0.4% 91-2000.	Same source.	
HIGH:	2.8% 86-90.	DOE Annual Energy Outlook, March 88. High Case.	(Ratio of US consumption to waterway traffic.)
	0.9% 91-95.	Same source.	
	0.8% 96-2000.	Same source.	

ALL OTHER COMMODITIES

LOW:	-2.4% 86-2000.	Historic rate.	(Average 1975-1985.)
MED:	-1.1% 86-2000.	DRI Waterborne Traffic Outlook, Dec 86.	(Waterway traffic.)
HIGH:	0.7% 86-2000.	Historic rate and NWS.	(Average 1978-1985.)

The projections resulting from application of the above growth rates by commodity and trend analysis can be seen by commodity in Figures 2 through 12 at the end of this section.

WATERWAY PROJECTIONS

Once national level projections by commodity had been generated, these figures were disaggregated down to individual waterways based on several factors including time series data, historic share by commodity, and trends in that share. Generally, each waterway's weighted average share of 1984-86 traffic by commodity was used to calculate that waterway's projected traffic for the same commodity. The exceptions are farm products and coal. For farm products each waterway's straight average of 1984-86 traffic was used to calculate its share of the national total. This share was then used to apportion national projected farm products traffic by waterway. For coal, each waterway's 1986 share of total 1986 coal movements was used due to recent rapid growth. This was an attempt to capture recent shifting shares for coal traffic. A further exception was made for the Monongahela, and Cumberland rivers, whose traffic levels were distorted in 1986. For these rivers a multiyear average share was used. Once a projection envelope was established for each waterway it was centered alternatively on the 1986 actual value and on the linear trend value on those waterways showing a significant linear trend over time. THe resulting maximum high and minimum low values were used as the final waterway projections. Projections for individual waterways are shown in Table A-2 at the end of this section.

As discussed earlier, historical data was analyzed and used for making projections for the total U.S. waterway system and for segments where a correlation between time and tonnage could be identified.

4. Operations and Maintenance Costs

a. This element presents the O&M costs, ton-miles and costs per ton-mile for nine segments of waterways and for waterways in each segment for the period of 1977 through 1986. In essence, the O&M cost per ton-mile shows the unit cost of operating a waterway .

b. The data source is the Navigation Cost Recovery Data Base System (NCRDBS), Corps of Engineers, 1986. Commercial navigation O&M costs are defined as those O&M expenditures for commercial navigation incurred by the Corps of Engineers on water resources projects which have navigation as an authorized purpose. These navigation costs include costs related to dredging, lock operations, major maintenance, other maintenance, and major rehabilitation. In single purpose navigation projects, recreation navigation costs are excluded from O&M costs. The included costs applicable to multiple purpose projects that contribute to navigation's O&M costs may pertain to projects on the fuel taxed waterway, such as on the Cumberland River, or upriver or on a tributary, such as on the Missouri River.

c. On the inland waterways there are 52 multiple purpose projects with navigation as an authorized purpose. For about 40 of those projects joint

costs have been allocated to navigation and other purposes, but for the other 10 projects there is no cost allocation formula. For multiple purpose navigation projects where costs have been allocated for reimbursable purposes, navigation costs include those that are specific to commercial navigation and those joint use costs allocated to navigation by the latest official cost allocation formula. The amount of joint costs varies from project to project and from year to year. The percentages in the cost allocation formula for navigation and other purposes vary from project to project, with the percentage for navigation ranging from about 1% to about 40%, but the percentages in each project's formula are fixed and do not change from year to year. In the NCRBDS for multiple purpose navigation projects where project costs have not been allocated, certain cost accounts are designated as navigation specific; some are designated as expenditures made for other specific purposes; and all other cost accounts are designated as joint use costs. In the NCRDBS 10% of these joint costs are assigned to navigation. Of the 30 waterways in the nine segments being studied here, 14 waterways have no multiple purpose nor Mississippi River and Tributaries (MR&T) projects, nine waterways have only one or two projects, and seven have four to nine projects. The Arkansas River system includes seven multiple purpose projects with navigation and the Missouri River has nine projects.

d. For the MR&T project construction costs are included with maintenance costs in NCRDBS because the MR&T's construction is long term and continuing like maintenance. Dikes and dredging are considered to be navigation and revetments are considered as joint costs. However, in NCRDBS 33% of MR&T joint costs are assigned to navigation. In this report the MR&T Old River costs have been used for the Atchafalaya River (segment 2) and the remainder have been used for the Mississippi River from the Ohio River to Baton Rouge (segment 3). Although the MR&T project extends into the Mississippi River from the Missouri River to the Ohio River (segment 2), only conventional maintenance costs and no MR&T costs are used here for that waterway.

5. Program Status

a. In the waterway segment section, this element describes the status of planning and design studies and rehabilitation and construction work, the year when work started and was or is scheduled to be completed, the total cost and the amount to be drawn from the Inland Waterway Trust Fund for the work, funding allocations through FY 1987, percent of work complete through FY 1987 based on allocations, and the FY 1988 budget request. The narrative also provides some explanation or justification for a study or project such as a problem being studied or corrected, basic features of the new project, or work that has been accomplished thus far, particularly as it relates to project operation.

b. Data sources.

(1) U.S. Army Corps of Engineers, Congressional Submission Justification Data, Fiscal Years 1988 and 1989;

(2) U.S. Army, Office of the Assistant Secretary, Annual Report FY 1985 of the Secretary of the Army on Civil Works Activities;

(3) U.S. Army Corps of Engineers, Water Resource Development by the Corps of Engineers (in various states), 1981 and 1985; and

(4) U.S. Army Corps of Engineers, Office of the Chief of Engineers, Civil Works Directorate, Operations-Readiness, Planning, and Programs divisions, Current Status Information on Planning Studies and Rehabilitation and Construction Projects, June 1987.

c. Status codes.

The codes in the tables on "Status of Construction, Rehabilitation, and Studies" are listed below:

C = Construction

R = Rehabilitation

S = Study

Studies include reconnaissance and feasibility surveys; preconstruction engineering and design (PED); condition; and project review studies. Navigation may be a purpose studied as part of flood damage prevention and comprehensive studies.

INA = Identified, not authorized

AS = Authorized, starting

ANS = Authorized, not started

CF = Continuing, funded

CNF = Continuing, not funded

C = Completed

Program codes C, R, and S are used in combination with six status codes, thus, Construction - Authorized, not started is coded as C-ANS.

c. Abbreviations

UNK = Unknown

6. Lock Capacity Characteristics

a. This element describes the "range" of lock capacity and percentage of "capacity used", both historical and projected.

b. The source of "capacity range" is National Waterways Study--A Framework for Decision Making--Final Report, Appendix D: National Waterways Reach Summaries, Institute for Water Resources, January 1983. "Capacity Range" numbers were originally reviewed by the districts during the National

Waterways Study. Although they were reviewed again by the districts in August 1987 and in March and summer of 1988, lock capacity data are preliminary and subject to revision. Historical tonnages (1977-1987) at locks are from lock PMS data and are presented to give an historical perspective. No projection of lock "capacity used" is presented at this time.

TABLE A-2
U.S INTERNAL WATERWAY TRAFFIC PROJECTIONS
BY SEGMENT: LOW AND HIGH, 1990, 1995 AND 2000
(MILLIONS OF TONS)

SELECTED WATERWAY SEGMENTS	ACTUAL 1986	1990 LOW	1990 HIGH	1995 LOW	1995 HIGH	2000 LOW	2000 HIGH	GROWTH RATE LOW	GROWTH RATE HIGH
UPPER MISSISSIPPI	73.7	82.5	92.0	87.6	102.1	93.3	112.4	1.7%	3.1%
MIDDLE MISSISSIPPI	97.7	106.3	117.4	112.9	130.3	120.3	144.8	1.5%	2.9%
MISSOURI R.	7.0	6.8	7.6	6.5	8.5	6.2	9.4	-0.9%	2.1%
LOWER MISSISSIPPI	156.2	168.5	187.8	178.3	209.6	189.5	234.0	1.4%	2.9%
ARKANSAS R.	8.4	8.9	11.5	9.1	13.5	9.6	15.5	1.0%	4.5%
ILLINOIS WATERWAY	42.3	44.5	49.9	47.2	54.9	50.1	60.1	1.2%	2.5%
OHIO RIVER SYSTEM	222.2	232.3	254.2	248.2	288.1	266.8	327.0	1.3%	2.8%
OHIO R. - MAINSTEM	195.6	204.1	224.3	217.7	253.9	233.7	287.7	1.3%	2.8%
MONONGAHELA R.	29.5	38.5	42.1	40.5	48.6	43.1	56.2	2.7%	4.7%
KANAWHA R.*	16.8	18.1	21.4	19.5	24.6	21.2	28.4	1.7%	3.8%
CUMBERLAND R.*	14.2	15.7	18.0	16.2	20.8	17.0	23.7	1.2%	3.5%
TENNESSEE R.	39.6	41.3	44.4	44.0	50.1	47.1	56.6	1.2%	2.6%
GULF INTRACOASTAL WW	105.7	102.0	112.4	99.9	121.3	101.7	131.0	-0.3%	1.5%
BLK WARRIOR-TOMBIGBEE	17.9	22.1	24.1	23.6	26.9	25.3	30.2	2.5%	3.8%
ATLANTIC INTRACOASTAL	4.4	4.7	5.2	5.2	6.5	5.7	8.1	1.9%	4.5%
COLUMBIA R.	14.1	15.8	21.5	16.4	22.6	17.3	24.7	1.5%	4.1%
US TOTAL INTERNAL	560.5	572.7	622.3	591.6	681.6	620.1	748.2	0.7%	2.1%

* KANAWHA TOTAL SHOWN IS 1986 DATA FROM WCSC. OHIO RIVER DIVISION ESTIMATES ACTUAL TONNAGE AT 18.2 MILLION. CUMBERLAND TOTAL SHOWN IS 1985 DATA. PRELIM. 1987 DATA FROM WCSC SHOW 16.1 MILLION TONS.

PROJECTIONS CALCULATED BY CEWRC-IWR USING:
1) NATIONAL GROWTH RATES BY COMMODITY GROUP ADAPTED FROM DRI, WEFA, USDA, DOE, IWR.
WATERWAY SEGMENT PROJECTIONS BASED ON AN AVERAGE SHARE OF COMMODITY TRAFFIC FROM NATIONAL PROJECTIONS, WHICH VARIED BY WATERWAY DEPENDING ON HISTORIC PATTERNS AND COMMODITY GROUP.
PROJECTIONS ARE PRELIMINARY AND SUBJECT TO REVISION.

2) LINEAR ADJUSTED PROJECTIONS CALCULATED BY ADDING THE DIFFERENCE (POSITIVE OR NEGATIVE) BETWEEN THE ORIGINAL BASE AND THE LINEAR ADJUSTED BASE TO EACH PROJECTED NUMBER. LINEAR ADJUSTED BASE IS 1986 CALCULATED VALUE USING LINEAR TREND ANALYSIS FOR 1965-1986 DATA BY WATERWAY AND FOR THE NATIONAL TOTAL. ONLY SELECTED WATERWAYS WERE CALCULATED BECAUSE OF A LACK OF DATA OR BECAUSE HISTORIC DATA EXHIBITED NO LINEAR RELATIONSHIP OVER TIME.

3) TREND PROJECTIONS BASED ON LINEAR REGRESSION ANALYSIS OF TIME SERIES TONNAGES FROM 1965-1986, AND ARE ONLY SHOWN FOR THOSE SEGMENTS WHICH DISPLAYED A LINEAR RELATIONSHIP OVER TIME.

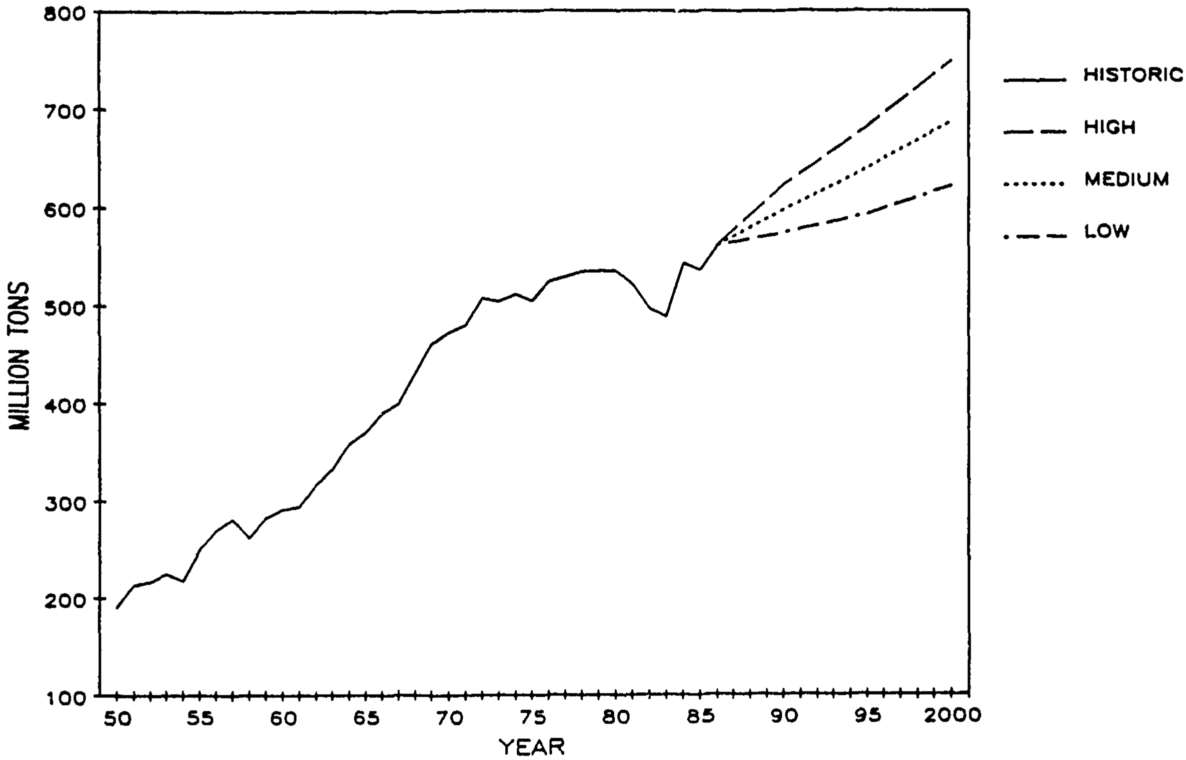
4) FOR WATERWAYS WITH NONLINEAR HISTORIC DATA OR INCOMPLETE DATA, TWO STANDARD DEVIATIONS OF THE HISTORIC DATA WERE CALCULATED. THIS RANGE WAS THEN APPLIED TO MEAN VALUES OF THE HIGH AND LOW PROJECTIONS TO GENERATE NEW PROJECTIONS FOR THE YEAR 2000. INTERMEDIATE PROJECTIONS WERE THEN INTERPOLATED.

5) THESE WATERWAY PROJECTIONS ACCOUNT FOR THE MAXIMUM RANGE OF FORECASTS, LOW TO HIGH, CALCULATED BY USING ALL OF THE ABOVE TECHNIQUES.

FIGURE A-2

U.S. TOTAL INTERNAL WATERBORNE COMMERCE

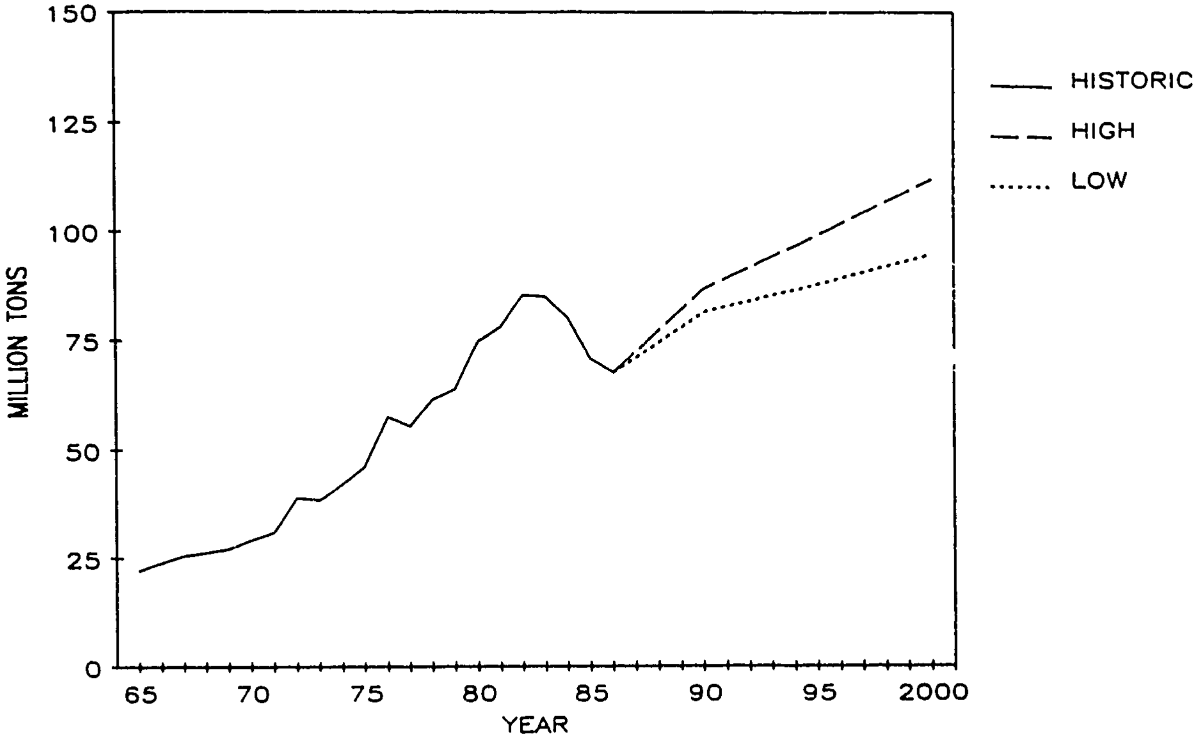
HISTORIC 1950-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

FIGURE A-3

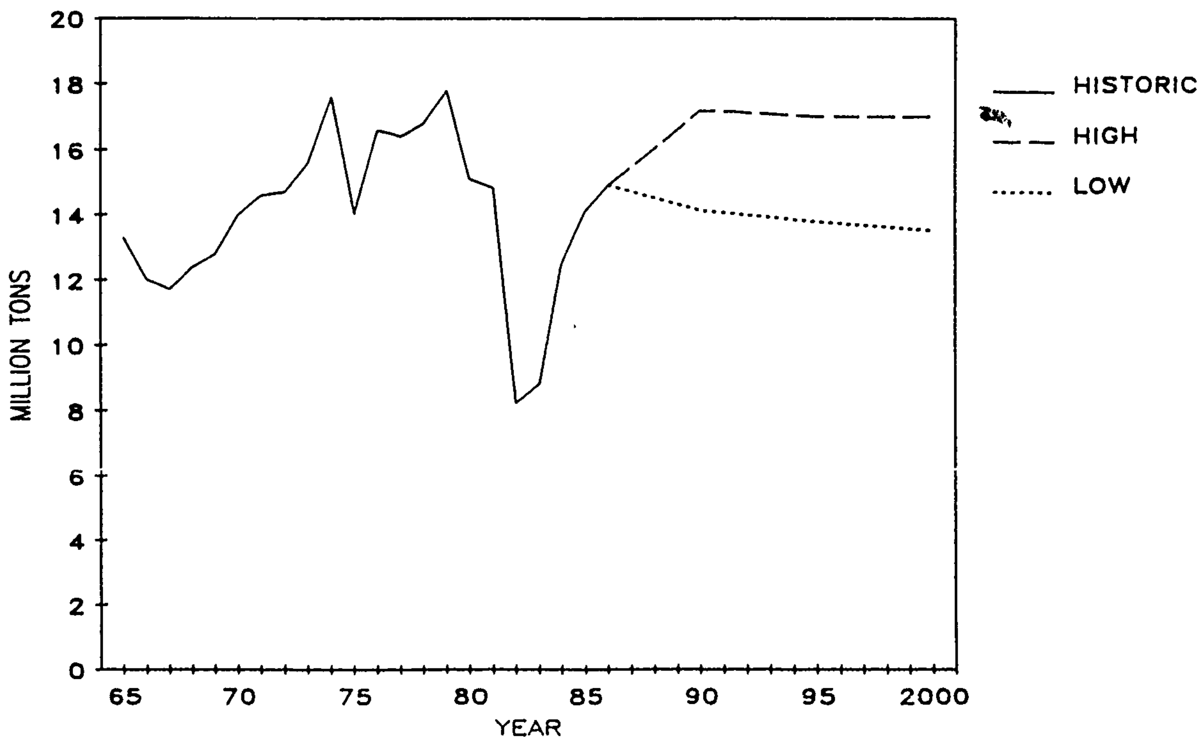
U.S. INLAND WATERWAY
FARM PRODUCTS TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR, OCT 88. FORECASTS FROM WEFA (HIGH), DRI (LOW).

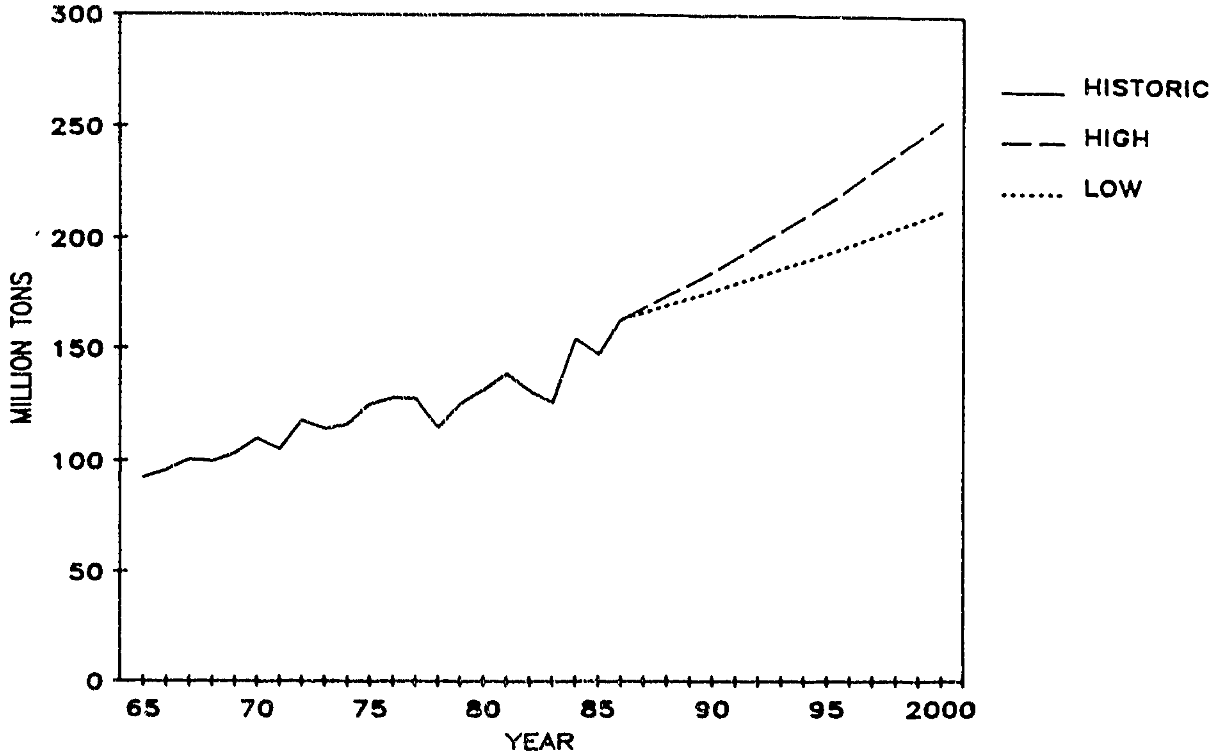
FIGURE A-4

U.S. INLAND WATERWAY
METALLIC ORES, PRODUCTS & SCRAP TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



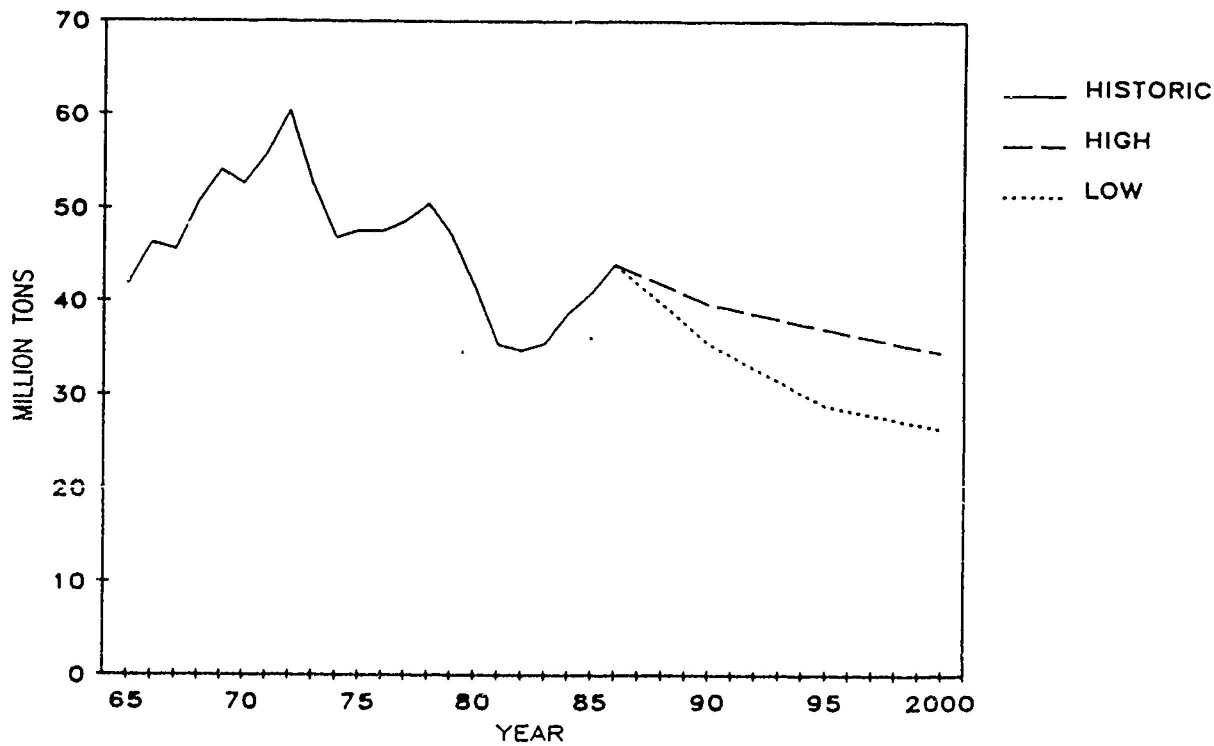
GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM DRI (HIGH) & WEFA (LOW).

FIGURE A-5
U.S. INLAND WATERWAY
COAL TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



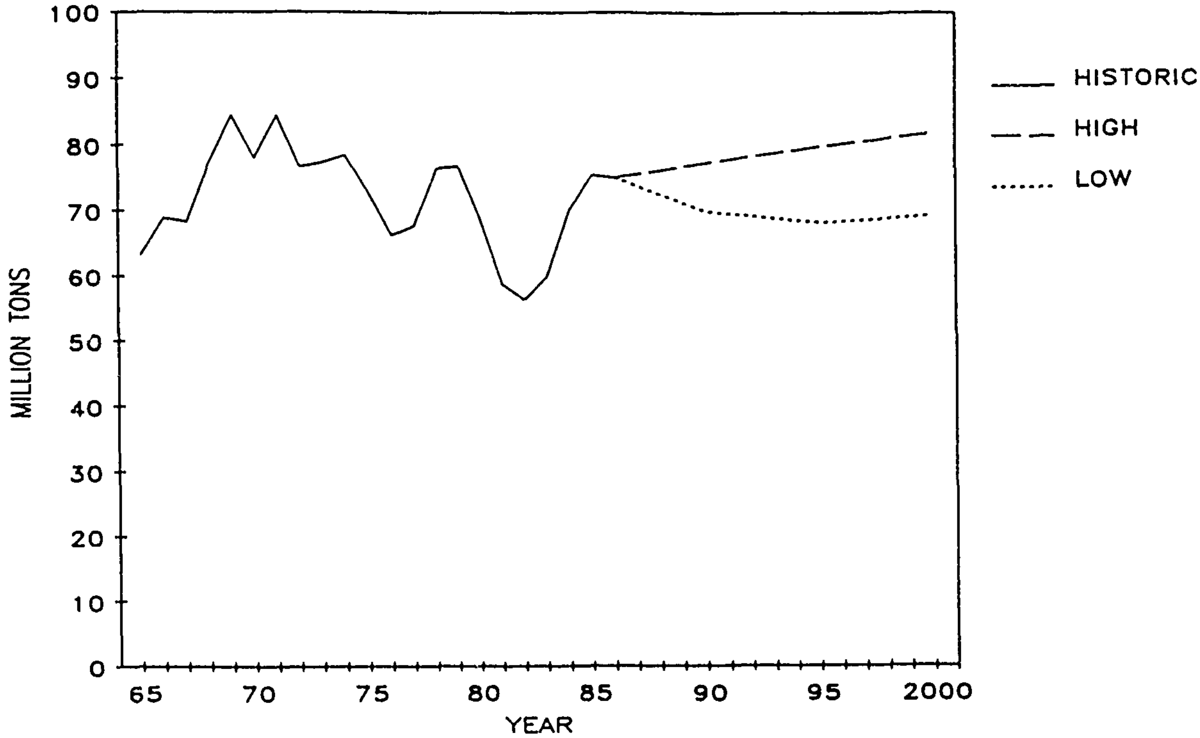
GRAPHED BY IWR. HISTORIC-WCSC. PROJECTED-DRI/DOE/IWR.

FIGURE A-6
U.S. INLAND WATERWAY
CRUDE PETROLEUM TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



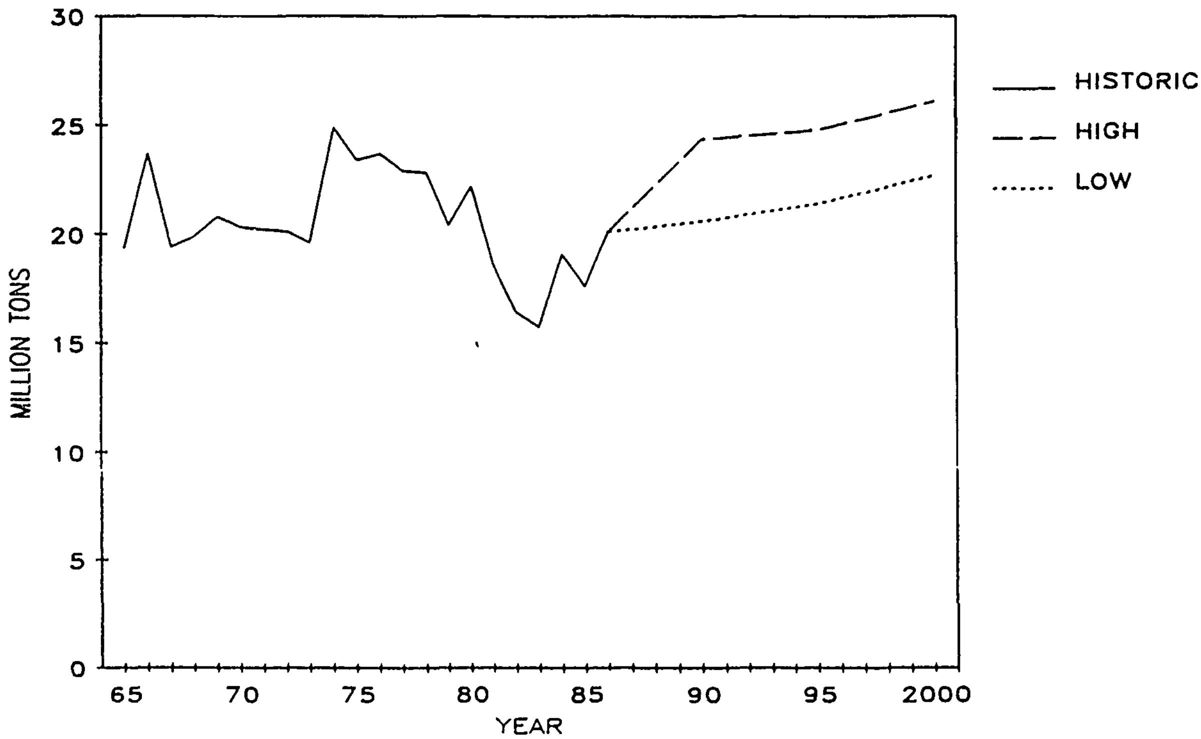
GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM DRI & DOE.

FIGURE A-7
U.S. INLAND WATERWAY
NONMETALLIC MINERALS & PRODUCTS TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



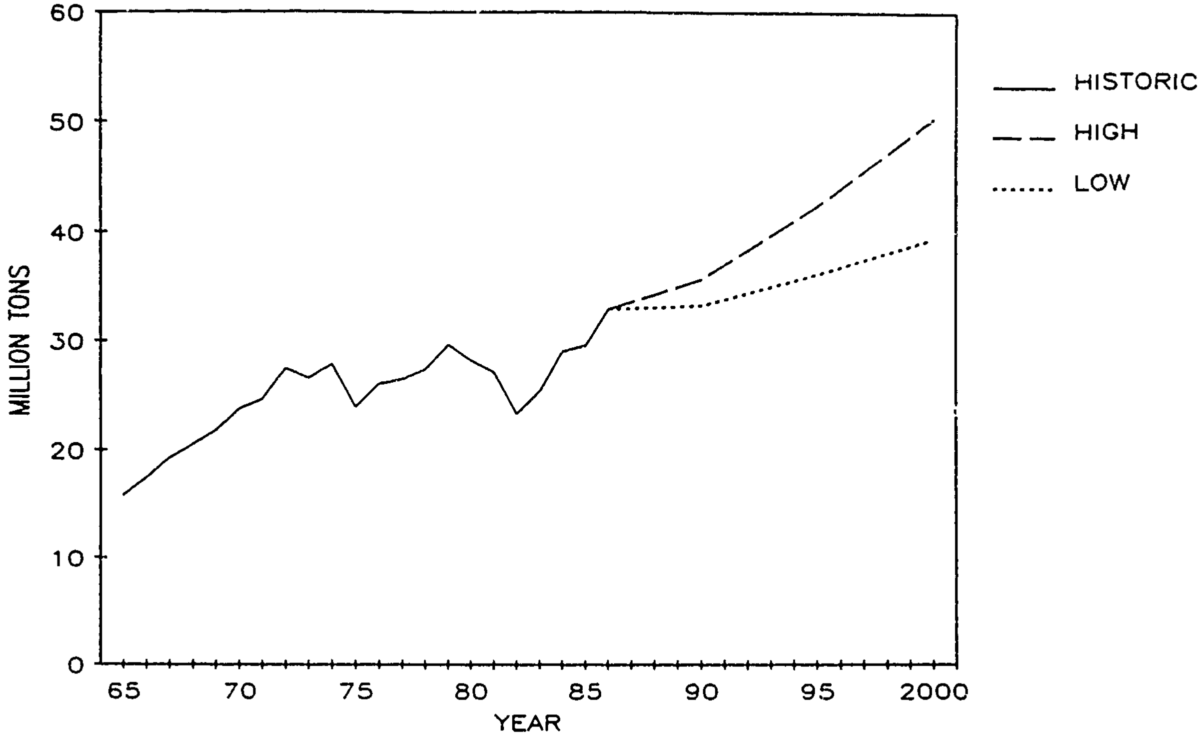
GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM IWR(HIGH) AND DRI(LOW).

FIGURE A-8
U.S. INLAND WATERWAY
FOREST PRODUCTS TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



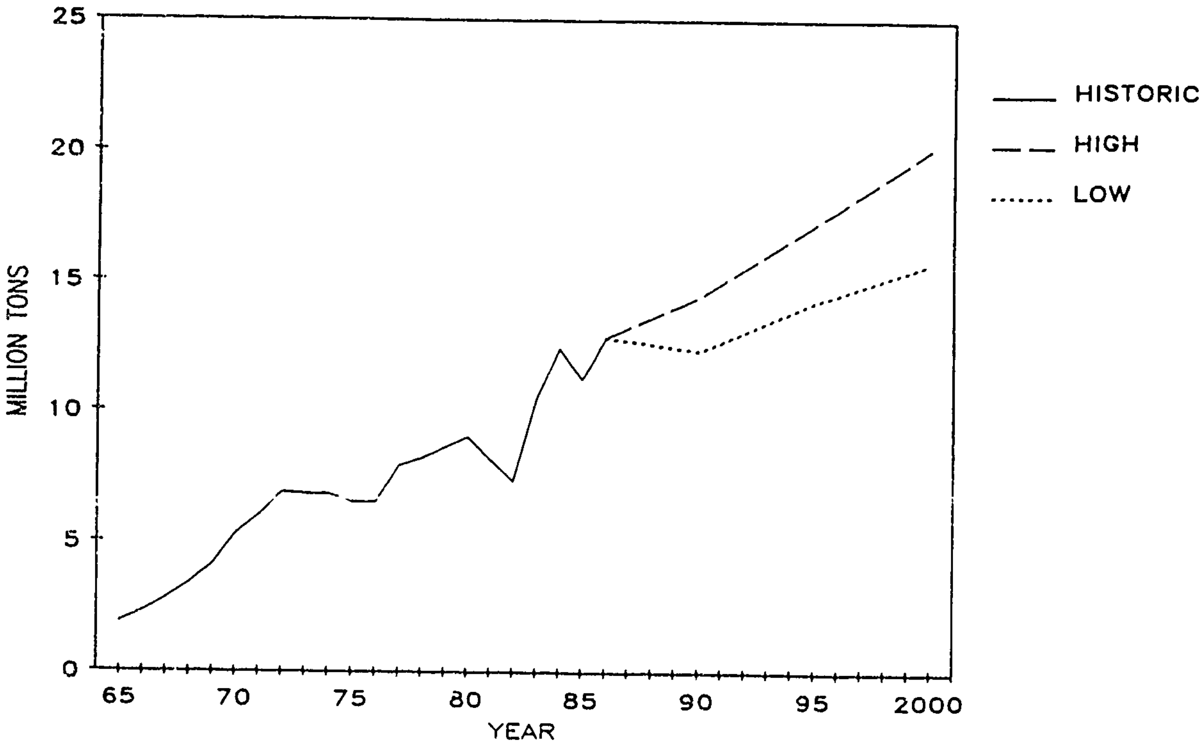
GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM DRI.

FIGURE A-9
U.S. INLAND WATERWAY
INDUSTRIAL CHEMICALS TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM DRI.

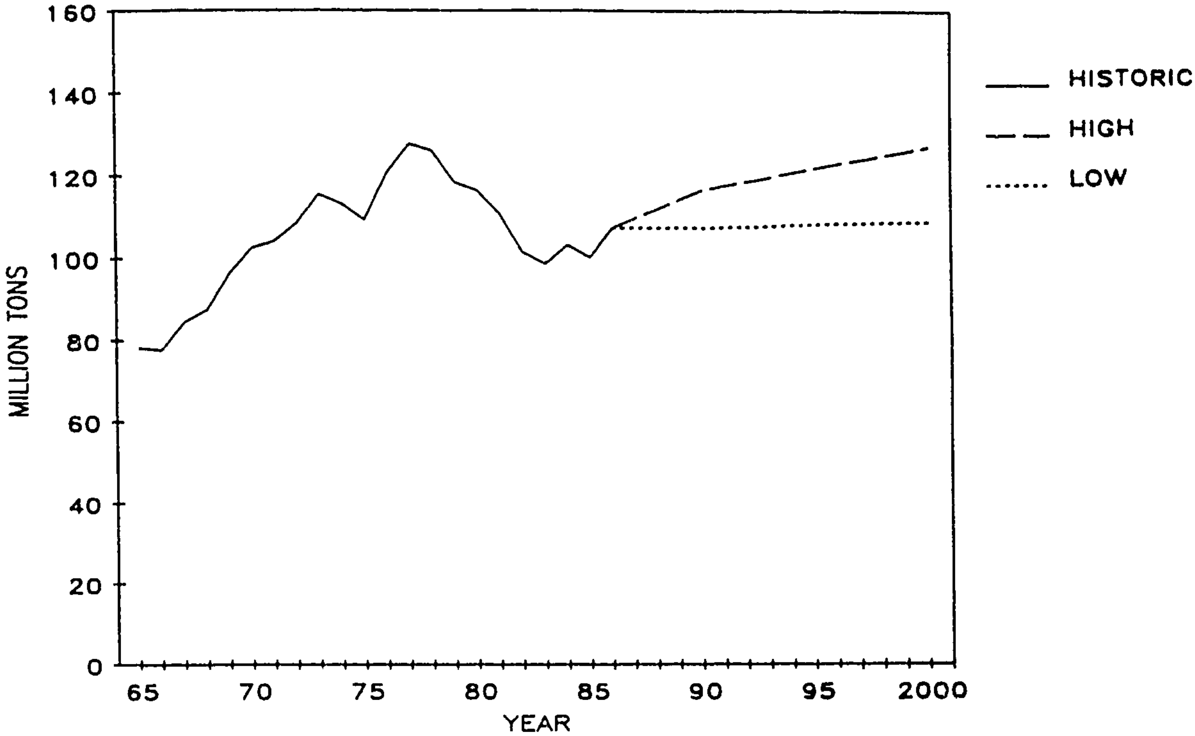
FIGURE A-10
U.S. INLAND WATERWAY
AGRICULTURAL CHEMICAL TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. FORECASTS ADAPTED FROM DRI (HIGH) & WEFA (LOW).

FIGURE A-11

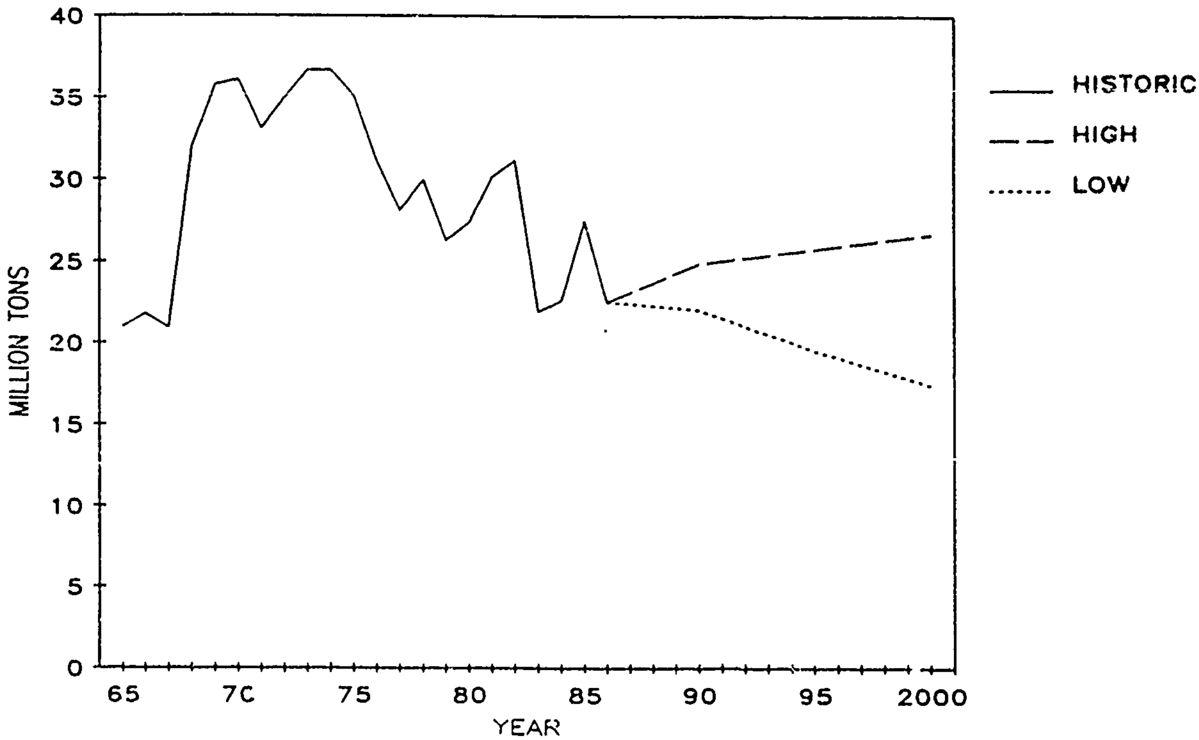
U.S. INLAND WATERWAY
PETROLEUM PRODUCTS TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR, OCT 88. FORECASTS ADAPTED FROM DRI & DOE.

FIGURE A-12

U.S. INLAND WATERWAY
ALL OTHER COMMODITIES TRAFFIC
HISTORIC 1965–1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR, OCT 88. FORECASTS FROM IWR.

SEGMENT NUMBER 1
UPPER MISSISSIPPI

1. PHYSICAL CHARACTERISTICS.

a. <u>Channels</u> (Figure A-1-1). The Mississippi River between the Missouri River and Minneapolis has been improved for navigation by a system of 28 locks and dams. The nine foot deep channel stretches 663 miles from mile 145 to mile 858 at the head of navigation with the project width being 200 feet up to Lock and Dam 22 (mile 301.2), with none specified for further upriver. The dams are spaced at irregular intervals varying from about 10 to 46 miles with the average pool length being 25 miles. The navigation season is restricted by river ice to between early April and late November in the upper portion and between late March and late December in the lower portion. The Minnesota, St. Croix, and Black Rivers are tributariesqith 9-foot navigation, although traffic on these rivers is not subject to the inland waterway fuel tax. The Federal Government maintains a 9-foot channel on the lower 14.7 miles of the Minnesota River; private interests maintain 9-foot depths an additional 7 miles upstream. The St. Croix River provides 9-foot navigation to river mile 24.5. The Black River's 9-foot project extends to mile 1.4. None have any locks.

b. <u>Locks</u> (Table A-1-1). At most sites a main lock of 600 feet long by 110 feet wide has been constructed. However, there are several exceptions. St. Anthony Falls Upper and Lower Locks have single locks of 400 by 56 feet while Locks and Dam 1 has twin locks of 400 by 56 feet. Lock and Dam 19 has a 1200 by 110 foot chamber. Auxiliary locks are found at three sites in two sizes, 360 by 110 feet at Locks and Dams 15 and 26, and 320 by 80 feet at Locks and Dam 14. In addition, the standard 600 by 110 foot locks are usually accompanied by the upper gate bay of a 360 by 110 foot auxiliary lock that can be completed when required by traffic. A lock at L&D No. 2, opened in 1930, is inoperable. The lift of the locks varies from 5 to 49 feet with an average lift of 13 feet. The locks are from 48 to 66 years old. A rehabilitation program is underway which has completed work on three chambers and is scheduled to complete rehabilitation on nine other locks by 1994.

2. PERFORMANCE CHARACTERISTICS (Table A-1-2).

The 1987 total average processing time ranged anywhere from 25 minutes to 961 minutes (16 hours). Fourteen locks exceeded the median value of 116.5 minutes. Total peak average processing time for the 1980-1987 time period ranged from 35 minutes (1982) at Upper St. Anthony's Falls to 1,272 (1980) for Lock and Dam 26 Mn. Chamber. The highest total peak average processing time during the 1980-1987 time period was 1,272 minutes (21.2 hours) in 1980 for Lock and Dam 26 Mn. Chamber. The 1987 total delay ranged from 25 hours (Upper St. Anthony's Falls) to 56,165 hours (Lock and Dam 26 Mn. Chamber). The median value of total delay is 1871 hours. Total delay generally tends to increase as you move downstream. The peak total delay for the 1980-1987 time period ranged from 316 hours (1980) for Upper St. Anthony's Falls to 165,274 hours (1980) for Lock and Dam 26 Mn. Chamber. Lock utilization for 1987 ranged for 15% to 97%. The median lock utilization value was 46% and most of the locks were concentrated around this value. The peak utilization data for the 1980-1987 period ranged from 41% (1986) for Lower St. Anthony's Falls to 97% (1987) for Lock and Dam 26 Mn. Chamber. Total downtime for 1987, ranged

from 0 hours to 692 hours. The median value is 29 hours and half the locks had downtime quite in excess of this median. The total peak downtime for the 1980-1987 time period varied from 26 hours in 1986 at Upper St. Anthony's Falls to 2,508 hours in 1984 at Lock and Dam 19. Total stall events ranged from 0 to 290, and the median value is 16 stall events. The peak for total stall events from 1980 through 1987 ranged from 17 at Lock and Dam 5a in 1983 to 721 at Lock and Dam 26 in 1984.

3. COMMODITY TRAFFIC (Tables A-2, A-1-3A,-4); (Figures A-1-2,-3).

a. Historical. Between 1975 and 1983 waterborne commerce on the Upper Mississippi River between the mouth of the Missouri River and the head of navigation at Minneapolis grew from just over 63 million tons to a peak of 84.1 million tons. Traffic was just over 72 million tons in 1985, primarily due to a decline in grain and oilseed movements. The 1986 traffic increased to 73.7 million tons, largely due to a jump in coal traffic. By way of historic comparison, traffic in 1970 was 53.8 million tons. The primary commodities are grains and oilseeds, petroleum products and coal. Other agricultural products and non-metallic minerals and products are also important. Grain and oilseed traffic grew from less than 25 million tons in 1975 to a peak of 43.7 million tons in 1983, when it accounted for 52 percent of the tonnage on the Upper Mississippi. With the decline in grain exports from the United States, grain and oilseed traffic dropped back to 29.4 million tons in 1985. Petroleum products traffic has shown a long-term gradual decline from 11.9 million tons in 1975 to 9.8 million tons in 1985, but increased slightly to 10.3 million tons in 1986. The volume of coal traffic over the last decade has been erratic, from a low of 6.1 million tons in 1981 to a high of nearly 11 million in 1986.

b. Forecast. Between 1986 and 2000, waterborne commerce on the Upper Mississippi is projected to increase from 73.7 million tons to between 93.3 and 112.4 million tons by 2000. These projections compare with the historic annual growth rate of 1.4 percent during the 1975-86 period. Accounting for nearly half (45 percent) of all tons in 1986, farm products make up the major commodities influencing future traffic forecasts. Recent increases in grain exports are projected to be sustained, resulting in a higher growth rate in the near term and a slower rate in the out-years.

c. Tonnages at Locks. Based on average annual percent change during the period of 1977-1987 average annual tonnage increase at individual locks varied from 0.4% (Lock and Dam 2) to 4.3% (Locks and Dams 14 and 17). For 1977-1987 period two locks showed a decline in tonnage (Lower St. Anthony Falls, -0.7% and Lock and Dam 1, -6.3%) per annum. Actual tonnage increases during the same period ranged from 0.4 million tons (Lock and Dam 2) to 13.2 million tons (Lock and Dam 26). Total tonnage at each lock in 1987 ranged from 0.8 million tons at Upper St. Anthony Falls to 69.3 million tons at Lock and Dam 26.

4. OPERATION AND MAINTENANCE COSTS (Table A 1 5).

O&M costs in actual dollars increased from about $26 million in 1977 to about $53 million in 1986. That was about a 21% increase in real terms when inflation (about 68%) during the same period was taken into account. Traffic increased from about 11 billion ton-miles in 1977 to about 13 billion ton-miles in 1986. O&M cost per ton-mile rose slightly from 2.3 mills in 1977 to

4.2 mills in 1986 (3.0 mills in real terms) This segment ranks the seventh lowest in cost per ton-mile of all nine segments.

5. PROGRAM STATUS (Table A-1-6).

a. Locks and Dam 26 will be replaced in June 1989 by a new dam and lock 1200 feet long and 110 feet wide. The $748.6 million project is 75 percent complete and will be 82 percent complete with funds requested for FY 1989. In addition, a second lock 600 feet long and 110 feet wide that was authorized in 1986 is scheduled to be operational by 1992 at an estimated cost of $213 million. It is 6 percent complete and will be 12 percent complete with funds requested for FY 1989. Significant work in 1988 on the dam and main lock include continuation and completion of the lock and dam second stage and initiation and completion of the cofferdam third stage and Burlington Northern Railroad Bridge relocation (about 70% of costs). Construction begins on the second lock in 1989 following engineering and design in 1988.

b. Above its confluence with the Illinois Waterway, navigation improvements on the Upper Mississippi River are in the form of major rehabilitation and major maintenance rather than construction of additional or replacement locks. However, the 50 to 53 year old standard 600 by 110 foot locks are usually accompanied by the upper gate bay of a 360 by 110 foot auxiliary lock that can be completed when required by traffic.

(1) The St. Paul District started rehabilitation in 1987 of Locks and Dams 3, 5A, 6, 7, 8, and 9 for a total cost of $32.2 million. The work is 13 percent complete and will be 25 percent complete with funds requested for FY 1989. The work involves replacement and/or refurbishing the mechanical and electrical systems and includes systems that operate the lock gates, the valves that control the locks water level, and the dam's movable gates. In 1982 the district completed for $44.6 million rehabilitation of Locks and Dam 1, whose twin 400 by 56 foot chambers are 56 and 71 years old.

(2) From 1986 through 1990 the Rock Island District is rehabilitating Locks and Dams 20, 21, and 22 at respective costs of $38.4, $13.8, and $15.1 million. The projects are respectively, 39, 41, and 40 percent complete and will be 56, 98, and 89 percent complete with funds requested for FY 1989. The work involves rehabilitation of the locks, lock gates, and lock machinery and equipment; rehabilitation of the dams roller and tainter gates and emergency bulkheads; and scour protection downstream of the dam. In 1980 and 1982 the district completed rehabilitation of the auxiliary chambers at Locks and Dams 14 and 19 for a total cost of $13.0 million, resulting in the latter being closed.

c. The Upper Mississippi River System Environmental Management Program includes long term resources monitoring (LTRM) with computerized inventory and analysis, habitat rehabilitation and enhancement projects, recreation improvements and studies, and traffic monitoring in the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin (Thus, this project also applies to the Middle Mississippi River segment). The 206.0 million project is scheduled for completion in 1997, except for the recreation component, which is unscheduled. The project is 4 percent complete in 1988 and will be 7 percent complete with funds requested for FY 1989.

6. LOCK CAPACITY CHARACTERISTICS (Table A-1-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-1-4.

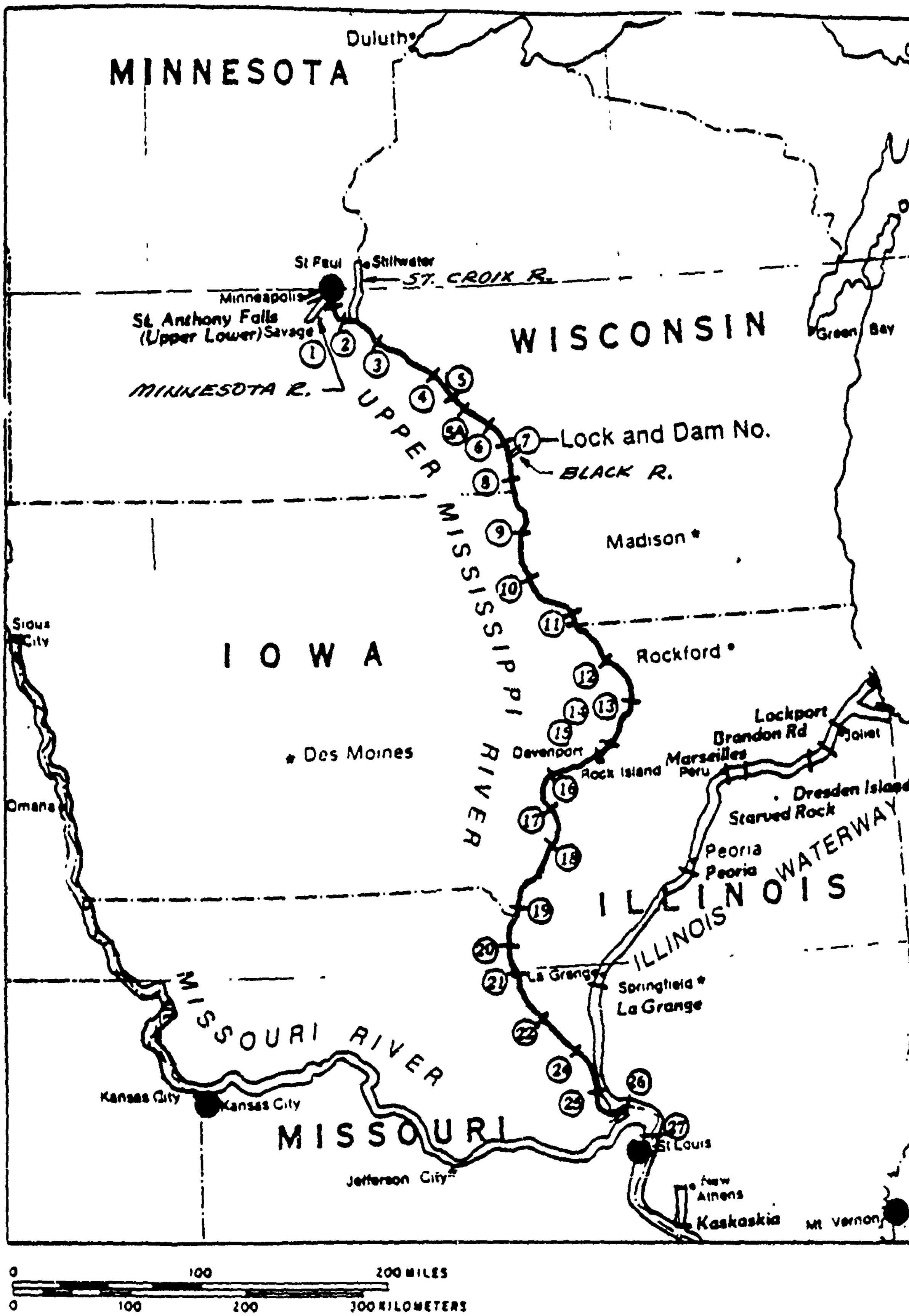


Figure A-1-1
Segment 1, Upper Mississippi

TABLE A-1-1
SEGMENT NUMBER 1
UPPER MISSISSIPPI

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Upper St. Anthony Falls	853.9	1963	25	56	400	49
Lower St. Anthony Falls	853.3	1959	29	56	400	25
No. 1	847.6	1930	58	56	400	38
	--	1932	56	56	400	38
No. 2	815.0	1930*	58	110	500	12*
	--	1948	40	110	600	12
No. 3	769.9	1938	50	110	600	8
No. 4	752.8	1935	53	110	600	7
No. 5	738.1	1935	53	110	600	9
No. 5a	728.5	1936	52	110	600	5
No. 6	714.0	1936	52	110	600	6
No. 7	702.0	1937	51	110	600	8
No. 8	679.0	1937	51	110	600	11
No. 9	647.0	1938	50	110	600	9
No. 10	615.0	1936	52	110	600	8
No. 11	583.0	1937	51	110	600	11
No. 12	556.0	1938	50	110	600	9
No. 13	522.0	1938	50	110	600	11
No. 14	493.9	1939	49	110	600	11
	493.3	1922	66	80	320	11
No. 15	482.9	1934	54	110	600	16
	--	1934	54	110	360	16
No. 16	457.2	1937	51	110	600	9
No. 17	437.1	1939	49	110	600	8
No. 18	410.5	1937	51	110	600	10
No. 19	364.2	1957	31	110	1200	38
No. 20	343.2	1936	52	110	600	10
No. 21	324.9	1938	50	110	600	10
No. 22	301.2	1938	50	110	600	10
No. 24	273.4	1940	48	110	600	15
No. 25	241.4	1939	49	110	600	15
No. 26	202.9	1938	50	110	600	24
No. 26	202.9	1938	50	110	360	24
No. 26 (under constr.)	200.8	1989	--	110	1200	24
No. 26 (under constr.)	--	1992	--	110	600	24

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.
* Not operable at this time.

TABLE A-1-2
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
U St Anthy Flls	14 (82)	2	25 (86)	23	35 (82)	25	316 (80)	25	48 (86)	15
L St Anthy Flls	52 (86)	4	29 (86)	29	73 (86)	33	774 (86)	82	41 (86)	20
No. 1	21 (80)	2	45 (80)	33	66 (80)	35	724 (80)	49	69 (86)	62
No. 2	82 (80)	35	73 (83)	71	149 (80)	106	2753 (80)	802	61 (86)	41
No. 3	43 (83)	27	72 (84)	68	115 (84)	95	1423 (83)	609	60 (86)	41
No. 4	66 (84)	24	75 (83)	70	140 (84)	94	1946 (84)	540	59 (86)	44
No. 5	48 (83)	24	72 (83)	70	120 (83)	94	1543 (83)	545	57 (86)	43
No. 5a	38 (83)	19	65 (83)	63	103 (83)	82	1298 (83)	417	57 (86)	42
No. 6	54 (83)	28	78 (83)	74	132 (83)	102	1818 (83)	647	59 (86)	45
No. 7	50 (83)	31	73 (83)	71	123 (83)	102	1901 (81)	722	60 (86)	47
No. 8	69 (83)	32	81 (83)	77	150 (83)	109	2293 (83)	719	60 (86)	45
No. 9	44 (80)	31	81 (83)	80	121 (84)	111	1652 (82)	695	59 (86)	44
No. 10	78 (83)	29	76 (84)	64	152 (83)	93	3184 (83)	855	58 (86)	43
No. 11	132 (83)	49	80 (84)	73	210 (83)	122	5471 (83)	1516	57 (85)	49
No. 12	145 (80)	60	79 (83)	63	218 (80)	123	5323 (80)	2519	54 (85)	46
No. 13	104 (80)	79	78 (83)	59	171 (83)	138	4119 (83)	3491	53 (85)	45
No. 14	211 (83)	78	77 (83)	68	288 (83)	146	11764 (83)	3969	65 (83)	60
No. 15	174 (80)	121	73 (83)	67	238 (80)	188	10514 (80)	8288	51 (83)	46
No. 16	333 (83)	216	81 (83)	78	294 (87)	294	19998 (83)	11256	64 (83)	53
No. 17	334 (87)	334	86 (87)	86	420 (87)	420	15981 (87)	15981	70 (83)	58
No. 18	241 (83)	111	85 (83)	82	326 (83)	193	14092 (83)	5385	69 (83)	52

TABLE A-1-2 (CONTINUED)
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
No. 19	154 (83)	45	67 (83)	62	221 (83)	107	9107 (83)	2226	47 (86)	43
No. 20	867 (87)	867	94 (87)	94	245 (83)	961	46030 (87)	46030	76 (87)	76
No. 21	214 (80)	135	83 (87)	83	290 (80)	218	12191 (80)	7264	60 (83)	52
No. 22	478 (83)	204	97 (81)	96	441 (80)	300	28945 (83)	11132	70 (83)	64
No. 24	642 (83)	246	89 (87)	89	730 (83)	335	40459 (83)	13328	69 (83)	63
No. 25	383 (83)	231	84 (87)	84	465 (83)	315	24627 (83)	12285	61 (87)	61
No. 26 Mn.Chmb	1131 (80)	465	91 (80)	87	1272 (80)	552	165274 (80)	56165	97 (87)	97

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-1-2

SEGMENT NUMBER 1

UPPER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
U St Anthy Flls	22 (87)	7	11 (85)	0**	5 (80)	1	26 (86)	8	42 (86)	18	5 (84)	0	6 (86)	4	52 (86)	22
L St Anthy Flls	758 (86)	15	16 (82)	1	12 (80)	0	758 (86)	16	37 (87)	37	5 (82)	1	17 (80)	1	39 (87)	39
No. 1	34 (80)	3	4 (82)	0	17 (80)	0	54 (80)	3	58 (80)	2	6 (82)	0	40 (80)	0	98 (80)	2
No. 2	230 (86)	0	16 (83)	0	258 (80)	28	273 (80)	28	45 (86)	0	8 (86)	0	38 (80)	1	53 (86)	1
No. 3	10 (82)	2	30 (82)	11	32 (80)	0	59 (82)	13	12 (82)	1	28 (82)	3	11 (82)	0	51 (82)	4
No. 4	89 (83)	2	799 (84)	0	47 (80)	0	835 (84)	2	21 (83)	1	30 (84)	0	9 (82)	0	43 (84)	1
No. 5	132 (84)	0	34 (83)	0	5 (82)	0	134 (84)	0	29 (84)	0	31 (83)	4	8 (82)	0	30 (84)	0
No. 5a	59 (83)	1	15 (84)	2	6 (83)	0	79 (83)	3	12 (83)	1	43 (82)	1	3 (83)	0	17 (83)	2
No. 6	67 (81)	0	79 (83)	0	34 (84)	1	101 (81)	1	22 (81)	0	19 (83)	0	8 (81)	1	36 (81)	1
No. 7	81 (81)	2	129 (83)	1	14 (85)	1	134 (83)	4	23 (81)	1	24 (84)	1	20 (80)	1	35 (81)	3
No. 8	99 (81)	1	33 (83)	2	4 (86)	0	121 (81)	3	29 (81)	1	21 (86)	2	11 (80)	0	41 (81)	3
No. 9	117 (84)	0	41 (86)	9	74 (81)	4	131 (84)	13	22 (84)	0	21 (86)	2	11 (81)	1	24 (84)	3
No. 10	122 (81)	0	69 (83)	0	18 (80)	0	158 (81)	0	26 (81)	0	62 (83)	0	19 (80)	0	37 (81)	0
No. 11	43 (86)	1	1087 (83)	6	39 (80)	23	1144 (83)	30	16 (86)	1	43 (83)	1	20 (80)	4	65 (83)	5
No. 12	15 (82)	0	135 (86)	13	64 (84)	6	154 (84)	19	10 (80)	2	39 (86)	24	24 (84)	13	64 (84)	39
No. 13	44 (87)	44	1478 (80)	3	15 (82)	2	1487 (80)	49	11 (87)	11	23 (85)	1	9 (80)	3	31 (85)	14
No. 14	1508 (86)	3	1369 (83)	10	142 (80)	66	1551 (86)	79	14 (86)	3	35 (84)	8	37 (83)	24	76 (83)	35

TABLE A-1-2 (CONTINUED)
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK* (PEAK YEAR)	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
No. 15	65 (86)	18	47 (87)	11	809 (80)	360	851 (80)	389	40 (86)	22	29 (83)	12	520 (87)	520	554 (87)	554
No. 16	380 (80)	12	1960 (83)	56	90 (87)	90	1981 (83)	158	48 (80)	7	58 (83)	44	15 (80)	12	75 (80)	63
No. 17	127 (80)	25	511 (86)	27	312 (82)	10	523 (86)	62	23 (80)	3	24 (84)	8	54 (80)	6	74 (80)	17
No. 18	61 (83)	27	1514 (81)	472	65 (83)	14	1529 (81)	513	23 (84)	13	58 (84)	18	48 (87)	48	95 (83)	79
No. 19	1950 (84)	49	804 (83)	17	444 (83)	80	2508 (84)	146	129 (83)	10	37 (85)	16	91 (80)	46	212 (83)	72
No. 20	123 (87)	123	409 (85)	16	105 (87)	105	486 (85)	244	79 (87)	79	45 (85)	10	59 (87)	59	148 (87)	148
No. 21	102 (82)	18	914 (85)	653	31 (82)	21	977 (85)	692	36 (86)	13	44 (85)	15	30 (86)	14	84 (85)	42
No. 22	62 (86)	50	1547 (81)	50	811 (86)	5	1694 (81)	105	14 (86)	7	67 (85)	15	138 (86)	6	83 (85)	28
No. 24	96 (86)	24	341 (83)	33	94 (85)	5	407 (86)	62	33 (80)	13	320 (83)	91	106 (87)	106	210 (87)	210
No. 25	780 (81)	78	667 (81)	47	1541 (80)	16	1765 (85)	141	118 (84)	40	106 (83)	13	144 (84)	25	110 (80)	78
L&D 26	1516 (80)	207	601 (83)	65	1551 (81)	105	1831 (80)	377	85 (82)	84	325 (85)	66	592 (83)	412	721 (84)	562

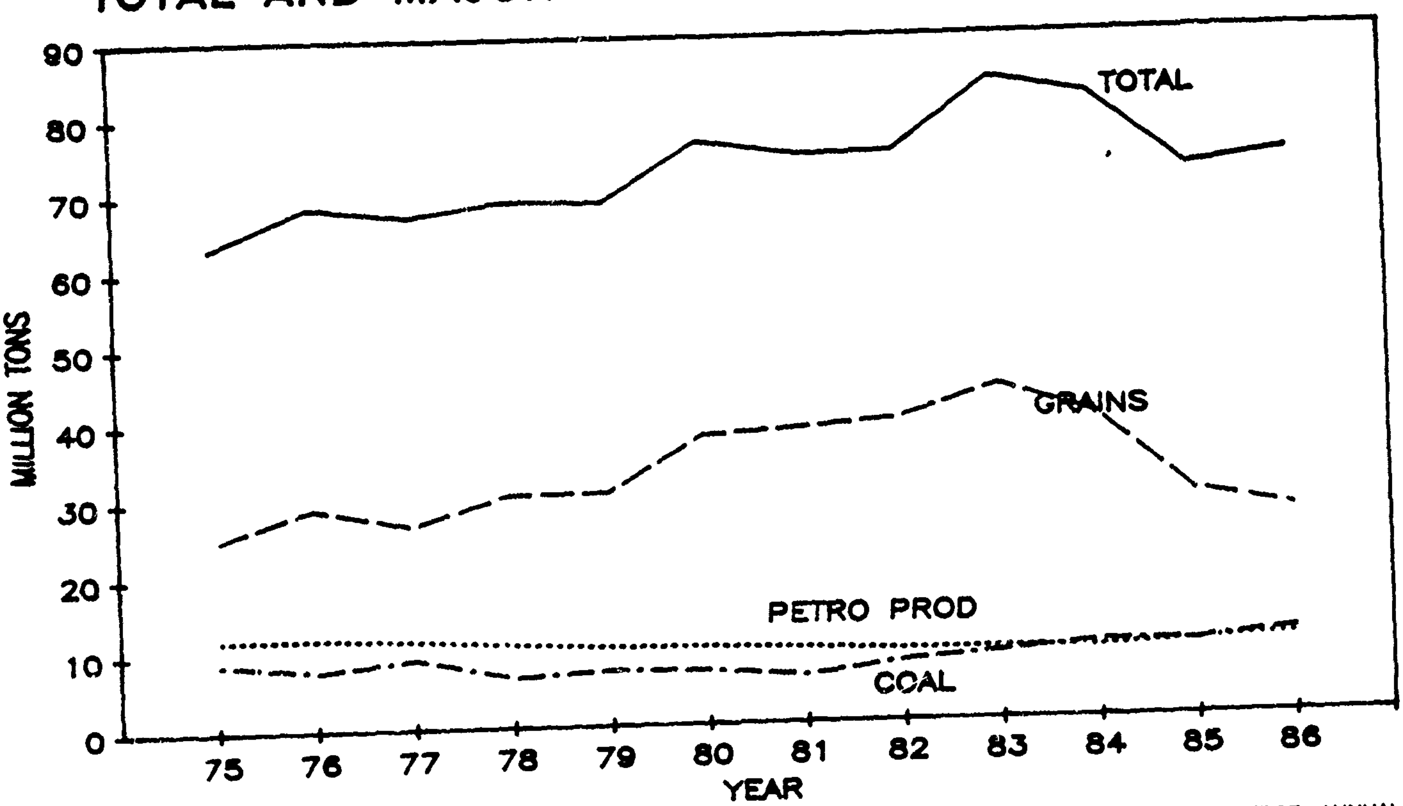
* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.
** Zero indicates that no data is available.
*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:
Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.
Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood
Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-1-3
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	24854	28940	26543	30353	30530	37761	38632	39642	43680	39809	29371	26973
Other Agricultural Prdcts	2300	3431	3456	3760	4196	4839	4642	4361	6074	4938	4479	5917
Metallic Ores	246	164	179	329	203	298	263	192	591	219	363	247
Coal	8806	7680	9057	6495	7189	7002	6144	7804	8771	9889	9687	10997
Crude Petroleum	256	848	752	831	368	512	760	761	1305	796	981	340
Non-Metlc Minerals & Prod	5400	5537	5650	6090	6258	5796	4951	5132	5342	6130	6371	6969
Lumber, Wood Prod. & Pulp	151	161	156	88	101	95	76	87	96	82	76	63
Industrial Chemicals	3566	3593	3408	3270	3067	3313	2906	2843	2721	3260	3321	4068
Agricultural Chemicals	3028	3194	3487	3426	3257	3353	3334	2076	3649	4608	4062	4493
Petroleum Prdcts	11893	11804	11394	10736	10287	10091	9653	9409	9400	9185	9818	10283
Metallic Products & Scrap	2483	2823	2666	2513	2724	2829	2706	1895	2314	2481	2807	3252
All Other Commodities	97	102	273	875	326	419	438	454	201	374	703	119
TOTAL	63080	68277	67021	68816	68506	76308	74505	74656	84144	81771	72039	73721

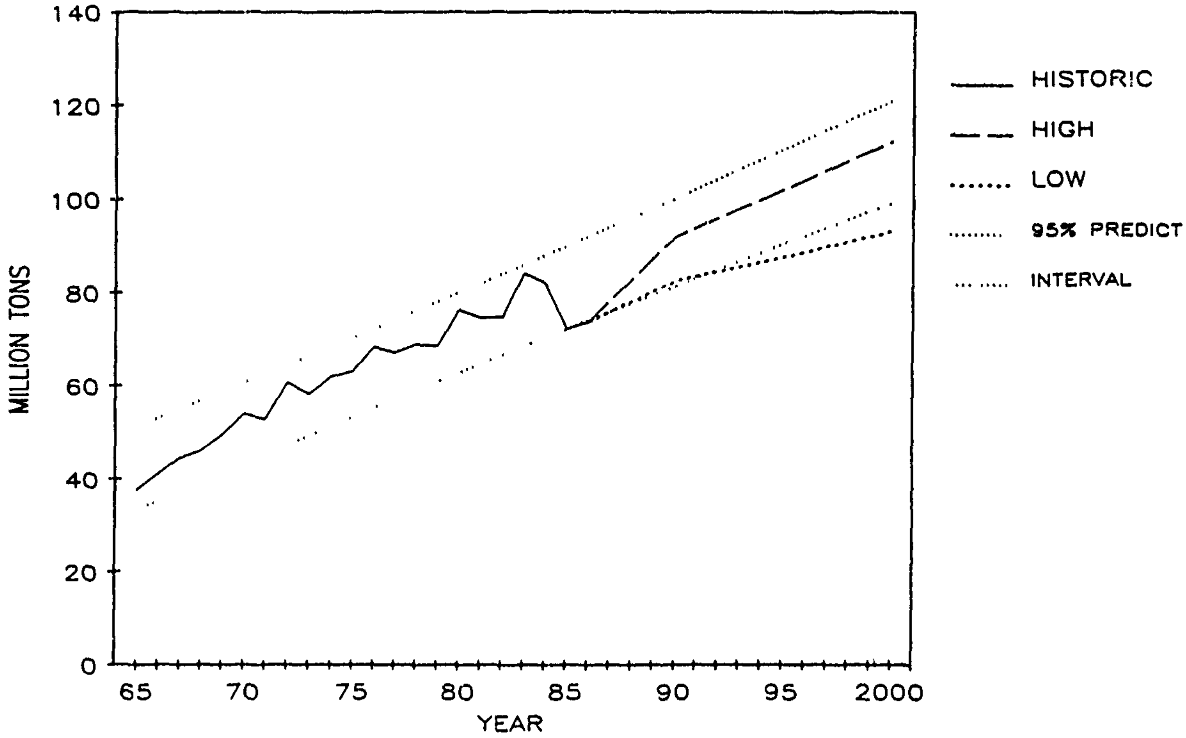
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-1-2
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-1-3
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-1-4
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	TONS (Millions) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
U St Anthy Fall	N.A.	N.A.	1.7	1.4	0.3	0.4	0.4	1.4	1.4	0.8	0.4	0.4	1.2	1.0	1.0	1	1	1
L St Anthy Fall	1.4	-0.7%	1.1	0.8	1.3	0.9	0.4	1.1	0.8	1.2	0.6	0.6	1.0	0.9	1.1	1	1	2
No. 1	2.5	-6.3%	1.7	1.3	1.3	0.9	0.4	1.4	1.3	1.2	0.6	0.6	1.2	1.0	1.1	1	1	2
No. 2	10.0	0.4%	13.0	9.3	10.4	2.3	8.1	1.7	1.3	1.3	0.6	0.7	7.5	7.2	7.7	8	7	8
No. 3	9.5	1.0%	11.7	9.0	10.5	2.4	8.1	1.4	1.1	1.3	0.7	0.6	8.3	7.8	7.9	9	8	8
No. 4	9.9	1.1%	12.1	9.4	11.0	2.5	8.5	1.4	1.1	1.3	0.7	0.6	8.6	8.4	8.5	9		9
No. 5	10.0	1.0%	11.9	9.5	11.0	2.7	8.3	1.4	1.1	1.3	0.7	0.6	8.7	8.4	8.6	9		9
No. 5a	10.0	1.1%	12.0	9.5	11.2	2.8	8.4	1.5	1.2	1.3	0.6	0.7	8.1	7.8	8.6	8	.	9
No. 6	10.7	1.6%	12.8	10.3	12.6	3.2	9.4	1.4	1.2	1.3	0.6	0.7	9.2	8.7	9.5	9	8	10
No. 7	10.7	1.6%	12.8	10.3	12.6	3.2	9.4	1.4	1.3	1.4	0.7	0.7	8.9	8.2	9.4	9	8	10
No. 8	10.9	1.9%	13.2	10.7	13.1	3.5	9.6	1.4	1.2	1.4	0.7	0.7	9.7	8.9	9.8	10	8	10
No. 9	12.0	1.6%	13.8	11.6	14.0	4.6	9.4	1.3	1.2	1.3	0.6	0.7	10.5	9.9	10.6	10	9	10
No. 10	12.7	2.0%	14.5	12.4	15.5	4.7	10.8	1.5	1.3	1.6	0.8	0.8	9.7	9.5	9.4	9	8	9
No. 11	13.1	1.9%	14.7	13.8	15.8	5.0	10.8	1.4	1.3	1.6	0.8	0.8	10.2	10.4	9.9	10	10	10
No. 12	14.1	3.2%	16.0	15.5	19.3	5.8	13.5	1.5	1.5	2.0	1.0	1.0	10.7	10.5	9.5	10	10	10
No. 13	14.1	3.2%	16.0	15.6	19.4	5.8	13.6	1.5	1.5	2.1	1.1	1.0	10.7	10.5	9.1	10	10	9
No. 14	16.0	4.3%	19.0	19.0	24.4	6.8	17.6	2.1	2.0	2.8	1.4	1.4	9.1	9.5	8.7	9	9	9
No. 15	16.8	4.1%	19.3	19.6	25.2	7.4	17.7	2.3	2.4	3.3	1.6	1.7	8.4	8.0	7.5	8	8	8
No. 16	18.4	4.0%	20.7	21.4	27.2	7.9	19.3	2.2	2.3	2.9	1.4	1.5	9.3	9.3	9.3	9	9	10

N.A. = NOT AVAILABLE

TABLE A-1-4 (continued)
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions) 1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
No. 17	19.1	4.3%	21.8	22.6	29.2	8.7	20.5	2.1	2.1	2.8	1.4	1.4	10.5	11.0	10.6	10	10	11
No. 18	19.7	4.2%	22.3	23.1	29.8	8.6	21.2	2.1	2.1	2.8	1.4	1.4	10.7	11.2	10.7	10	11	11
No. 19	21.7	3.7%	23.2	24.3	31.2	8.5	22.7	2.1	2.1	2.8	1.4	1.4	11.2	11.5	11.2	11	11	12
No. 20	22.1	3.7%	23.7	24.9	31.9	8.7	23.2	2.2	2.2	2.9	14.2	14.7	10.8	11.3	11.1	11	11	12
No. 21	23.0	3.8%	24.4	26.0	33.4	8.9	24.5	2.3	2.4	3.0	1.5	1.5	10.8	10.8	11.1	11	11	12
No. 22	23.6	3.8%	25.1	26.9	34.2	9.0	34.2	2.3	2.5	3.1	1.5	1.6	10.7	10.6	11.0	10	10	12
No. 24	24.4	3.8%	26.1	28.2	35.3	9.2	26.1	2.5	2.7	3.3	1.6	1.7	10.3	10.3	10.8	10	10	12
No. 25	24.5	3.7%	26.0	28.2	35.3	9.2	26.1	2.5	2.7	3.3	1.6	1.7	10.4	10.3	10.8	10	10	12
No. 26 Mn Chmb	56.1	2.1%	57.3	61.6	69.3	21.4	47.9	6.7	7.0	7.4	3.7	3.7	8.5	8.8	9.3	8	8	10

N.A. = NOT AVAILABLE
SOURCE: Lock Performance Monitoring System (PMS) Corps of Engineers, 1986.

TABLE A-1-5
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENENCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
UPR MISS R										
Minn-Mo R	25,922	44,088	37,275	34,876	36,521	38,904	48,482	58,317	50,708	53,481
Subtotal	25,922	44,088	37,275	34,876	36,521	38,904	48,482	58,317	50,708	53,481

TON MILES OF TRAFFIC (000) CY 1977-1986

UPR MISS R										
Minn-Mo R	11,380,456	12,908,444	13,269,370	15,155,731	15,828,796	14,630,245	18,159,405	18,096,466	13,023,160	12,871,936
Subtotal	11,380,456	12,908,444	13,269,370	15,155,731	15,828,796	14,630,245	18,159,405	18,096,466	13,023,160	12,871,936

O & M COSTS PER TON MILE ($) 1977-1986

UPR MISS R										
Minn-Mo R	0.0023	0.0034	0.0028	0.0023	0.0023	0.0027	0.0027	0.0032	0.0039	0.0042
Segment	0.0023	0.0034	0.0028	0.0023	0.0023	0.0027	0.0027	0.0032	0.0039	0.0042

NOTE: FY 1987 costs in order by the waterway(s) above are 60,356, and the subtotal is 60,356
1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-1-6
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
MISSISSIPPI RIVER								
Upr. Miss. R.								
Envr. Prog.	CCF	1986	1997	206,000	0	7,177	4	7,000
L&D 1	RC	1978	1982	44,600	0	44,600	100	0
L&D 3	RCF	1987	1994	37,700 (1)	0	10,390 (1)	28 (1)	4,000 (1)
L&D 5A	RCF	1987	1994	- (1)	0	- (1)	- (1)	- (1)
L&D 6	RCF	1987	1994	- (1)	0	- (1)	- (1)	- (1)
L&D 7	RCF	1987	1994	- (1)	0	- (1)	- (1)	- (1)
L&D 8	RCF	1987	1994	- (1)	0	- (1)	- (1)	- (1)
L&D 9	RCF	1987	1994	- (1)	0	- (1)	- (1)	- (1)
L&D 14 Aux	RC	1981	1981	7,800	0	7,800	100	0
L&D 19 Aux	RC	1977	1980	5,150	0	5,150	100	0
L&D 20	RCF	1986	1990	38,400 (2)	0	14,865	39	6,800
L&D 21	RCF	1987	1990	13,800	0	5,700	41	7,800
L&D 22	RCF	1987	1990	15,100	0	6,090	40	7,300
L&D 26 Main	CFC	1979	1989	755,400	0	564,638	75	50,000
L&D 26 Aux	CFC	1986	1992	213,000	106,500	12,136	6	13,000

(1) Total amount for Locks and Dams 3 and 5A through 9.
(2) Authorization and funding status under review at USACE.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-1-7
SEGMENT NUMBER 1
UPPER MISSISSIPPI

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
U St. Anthy Fall	1963	9	12	N.A.	1.7	1.4	0.8	N.A.	N.A.	N.A.	8.9%	6.7%	15
L St. Anthy Fall	1959	9	12	1.4	1.1	0.8	1.3	-19.0	-42.9	-7.1	14.4%	10.8%	20
1	1930	19	22	2.5	1.7	1.3	1.3	-33.0	-48.0	-48.0	6.8%	5.9%	62
	1932												
2	1930	36		10.0	13.0	9.3	10.4	31.0	-7.0	4.0	28.9%	N.A.	41
	1948												
3	1938	48		9.5	11.7	9.0	10.5	22.0	-5.3	10.5	21.9%	N.A.	41
4	1935	48	49	9.9	12.1	9.4	11.0	22.0	-5.1	11.1	22.9%	22.4%	44
5	1935	48	49	10.0	11.9	9.5	11.0	20.0	-5.0	10.0	22.9%	22.4%	43
5A	1936	49		10.0	12.0	9.5	11.2	20.0	-5.0	12.0	22.9%	N.A.	42
6	1936	49	50	10.7	12.8	10.3	12.6	20.0	-3.7	17.8	25.7%	25.2%	45
7	1937	49	50	10.7	12.8	10.3	12.6	20.0	-3.7	17.8	25.7%	25.2%	47
8	1937	49	50	10.9	13.2	10.7	13.1	21.0	-1.8	20.2	26.7%	26.2%	45
9	1938	48	50	12.0	13.8	11.6	14.0	15.0	-3.3	16.7	29.2%	28.0%	44
10	1936	48	50	12.7	14.5	12.4	15.5	14.0	-2.4	22.0	32.3%	31.0%	43
11	1937	36	37	13.1	14.7	13.8	15.8	13.0	5.3	20.6	43.9%	42.7%	49
12	1938	39	45	14.1	16.0	15.5	19.3	14.0	9.9	36.9	49.5%	42.9%	46
13	1938	45	46	14.1	16.0	15.6	19.4	14.0	10.6	37.6	43.1%	42.2%	45
14	1922	51	52	16.0	19.0	19.0	24.4	19.0	18.8	52.5	47.8%	46.9%	60
	1939												
15	1934	49	50	16.8	19.3	19.6	25.2	15.0	16.7	50.0	51.4%	50.4%	46
	1934												

TABLE A-1-7 (continued)
SEGMENT NUMBER 1
UPPER MISSISSIPPI RIVER

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
16	1937	48	49	18.4	20.7	21.4	27.2	12.0	16.3	47.8	56.7%	55.5%	53
17	1939	53	54	19.1	21.8	22.6	29.2	14.0	18.3	52.9	55.1%	54.1%	58
18	1937	55	56	19.7	22.3	23.1	29.8	13.0	17.3	51.3	54.2%	53.2%	52
19	1957	64	68	21.7	23.2	24.3	31.2	7.0	12.0	43.8	48.8%	45.9%	43
20	1936	53	57	22.1	23.7	24.9	31.9	7.0	12.7	44.3	60.2%	56.0%	76
21	1938	52	57	23.0	24.4	26.0	33.4	6.0	13.0	45.2	64.2%	58.6%	52
22	1938	44	52	23.6	25.1	26.9	34.2	6.0	14.0	45.0	77.8%	65.8%	64
24	1940	59	60	24.4	26.1	28.2	35.3	7.0	15.6	44.7	59.8%	58.8%	63
25	1939	59	60	24.5	26.0	28.2	35.3	6.0	15.1	44.1	59.8%	58.8%	61
26	1938	70	75	56.1	57.3	61.6	69.3	2.0	9.8	23.5	99.0%	92.4%	97

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 2
MIDDLE MISSISSIPPI

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-2-1). This segment includes the Mississippi River from the mouth of the Missouri River to the mouth of the Ohio River (195 miles), the Missouri River from Sioux City, Iowa, to its mouth (735 miles), and the Kaskaskia River from Fayetteville, Illinois, to its mouth (36 miles). The project depth is 9 feet. Project channel widths on the Mississippi River are 300 feet north to St. Louis and 200 feet from St. Louis to the Missouri River. They are 225 feet on the Kaskaskia River and 300 feet on the Missouri River, except for a 250 foot limitation from Miami to the mouth. Upstream dams and lakes provide regulated flows for navigation on the Missouri and Kaskaskia Rivers. The navigation season is the entire year on the middle Mississippi and Kaskaskia Rivers except for unusually cold periods. The navigation season on the Missouri River is normally restricted to eight months from 1 April through 30 November. Water flow under drought conditions may be insufficient to maintain authorized channel dimensions.

b. Locks (Table A-2-1). There are no locks on the Missouri River. There are only two lock sites in this segment. Locks and Dam 27 on the Mississippi River at St. Louis has two chambers of 1200 by 110 and 600 by 110 feet with a 24 foot lift. Kaskaskia Lock is 600 by 84 feet with a 32 foot lift. Dikes and revetments on the Mississippi River below Locks and Dam 27 and on the Missouri River restrict the rivers and help maintain the channel and operating depths. The lock facilities are 35 and 15 years old respectively.

2. PERFORMANCE CHARACTERISTICS (Table A-2-2).

The 1987 total average processing time ranged from 83 minutes (1.38 hours) to 88 minutes (1.47 hours). For the two locks in this segment, the median value is 85.5 minutes. Total peak average processing time for the 1980-1987 time period ranged from 83 minutes at Kaskaskia in 1987 to 118 at Lock and Dam 27 Main Chamber in 1985. The highest total peak average processing time for the 1980-1987 time period was 118 minutes (1.97 hours) at Lock and Dam 27 Main Chamber in 1985. The 1987 total delay for the two locks in this segment ranged from 289 hours to 9,125 hours. The median value of total delay is 5,356 hours. The peak total delay for the 1980-1987 time period ranged from 1,587 hours at Kaskaskia in 1987 to 13,520 hours at Lock and Dam 27 Main Chamber in 1985. Given that there are only two locks in this segment the highest peak total delay was 13,520 hours for Lock and Dam 27 Main Chamber in 1985. Lock utilization for 1987 ranged from 11% to 62%, and the median value is 26.5%. The peak utilization from 1980 through 1987 ranged from 13% (1985) at Kaskaskia to 65% (1985) at Lock and Dam 27 Main Chamber. Between the two locks, the highest peak utilization for the 1980-1987 time period was 65% in 1985 at Lock and Dam 27 Main Chamber. Total downtime for 1987 varied from 246 hours to 1558 hours. The median downtime value is 902 hours. The total peak downtime for the 1980-1987 time period ranged from 1,532 hours (1980) at Lock and Dam 27 Main Chamber to 1,558 hours (1987) at Kaskaskia. In this segment, the highest peak total downtime from 1980 through 1987 occurred at Kaskaskia in 1987 (1,558 hours). Total number of stall events for the two locks in this segment for 1987 ranged from 6 to 55, and the median value is 31. The peak

total number of stall events from 1980 through 1987 varied from 23 in 1985 at Kaskaskia to 123 in 1981 at Lock and Dam 27 Main Chamber. Between the two locks in the segment, the highest number of stall events for the 1980-1987 time period occurred at Lock and Dam 27 Main Chamber in 1981 (123 stall events).

3. COMMODITY TRAFFIC (Tables A-2, A-2-3A,-3B,-4); (Figures A-2-2A,-2B,-3A, -3B).

a. Historical. Waterborne commerce on the Middle Mississippi River between the mouth of the Missouri and the mouth of the Ohio grew from 71.5 million tons in 1975 to a peak of 103.6 million tons in 1984, before dropping back to 92.7 million tons in 1985. Tonnage recovered to 97.7 million in 1986, an increase of 5.4% over the previous year. The peak achieved in 1984 was largely attributable to grains and oilseeds, which accounted for 42 percent of the traffic in that year. Grain and oilseed traffic has since declined to 32 million tons in 1986 reflecting to the overall decline in U.S. grain and oilseed exports before turning around in 1987. Coal tonnage has shown considerable growth, increasing from a low of 8.6 million tons in 1978 to a new peak of 21.5 million tons in 1986. Petroleum products are also important on the Middle Mississippi, but tonnages have generally declined over the last decade. Peak tonnage of 10.7 million in 1976 fell slowly to around 8 million tons in 1985 before recovering to 8.7 million tons in 1986, the highest level since 1981. Traffic in non-metallic minerals has grown from less than 4.8 million tons in 1975 to nearly 8.4 million tons in 1986. In addition to grain, the movement of other agricultural products are also significant on the Middle Mississippi, as are movements of agricultural chemicals.

Traffic on the Missouri River over the past decade has varied between a low of 4.9 million tons in 1982 and a high of 7.9 million in 1978. Tonnage in 1986 was nearly 7 million. The primary commodities include non-metallic minerals and products (64 percent of total traffic in 1986), grains and oilseeds, and agricultural chemicals.

b. Forecast. Waterborne commerce on the Middle Mississippi segment is projected to increase from 97.7 million tons in 1986 to between 120.3 and 144.8 million tons by 2000. Accounting for over 41 percent of all tons in 1986, farm products form the major commodity group influencing future traffic forecasts. Because of the uncertainty of agricultural policy in the U.S. and abroad, future grain exports could vary greatly. An important element in forecasting Middle Mississippi traffic is the fact that a significant share is through traffic originating and destined elsewhere. Therefore projections for this segment are highly dependent on economic conditions elsewhere.

Between 1986 and 2000, waterborne commerce on the Missouri River is expected to grow from weighted base year traffic of 6.8 million tons to between 6.2 and 9.4 million tons by 2000. This projection is adjusted to take into account historic wide fluctuations in traffic on this river. The historic annual growth rate from 1975-86 was 1.1 percent. Accounting for well over half of all tons in 1986 (64 percent of traffic), nonmetallic minerals and products (mostly sand and gravel) make up the major commodity group influencing future traffic forecasts.

c. Tonnage at Locks. Based on average annual percent change during the 1977-1987 period average annual tonnage increase at Lock and Dam 27 was 2.0% and Kaskaskia had an increase of 9.1%. Lock and Dam 27 actual tonnage has risen 13.8 million tons and Kaskaskia 1.8 million tons, respectively during the 1977-1987 period. However, Kaskaskia tonnage in 1987 was 3.1 million tons, down from 3.8 million tons in 1985.

4. OPERATION AND MAINTENANCE COSTS (Table A-2-5).

O&M costs for 1986 exceeded that for 1977 by about $1.4 million (or 8 percent). That is about a 42% decline in real terms when adjusted for about 68% inflation from 1977 to 1986. During the period of 1980 to 1985 the O&M costs ranged about $12 million to about $21 million in actual dollars. Traffic increased from about 14 billion ton-miles in 1977 to about 18 billion ton-miles in 1986. O&M cost per ton-mile decreased from 1.2 mills (in 1985) to 1.0 mills (in 1986). The segment ranked the second lowest in cost per ton-mile of all nine segments.

5. PROGRAM STATUS (Table A-2-6).

a. The project on the Mississippi River between the Ohio and Missouri Rivers (Regulating Works) involves construction of improvements, such as channel realignments, dikes, and revetments, to reduce bank erosion and to improve the nine-foot channel for dependable year-round navigation. Construction began in 1910 and is scheduled to be complete in 2000 at an estimated total cost of $187 million. The project is 63 percent complete and will be 66 percent complete with funds requested for FY 1989.

b. The Missouri River, Yankton (South Dakota) to the Mouth, study is a multipurpose study of the basin. The $2.3 million study authorized in 1959 may be started if a sponsor is obtained. It was submitted for deauthorization in September 1987. The study is in response to concerns of the lower basin states regarding possible future diversions of water upstream and impacts on navigation, hydroelectric power generation, stream degradation, flood protection by levees, recreation, and fish and wildlife.

6. LOCK CAPACITY CHARACTERISTICS (Table A-2-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-2-4.

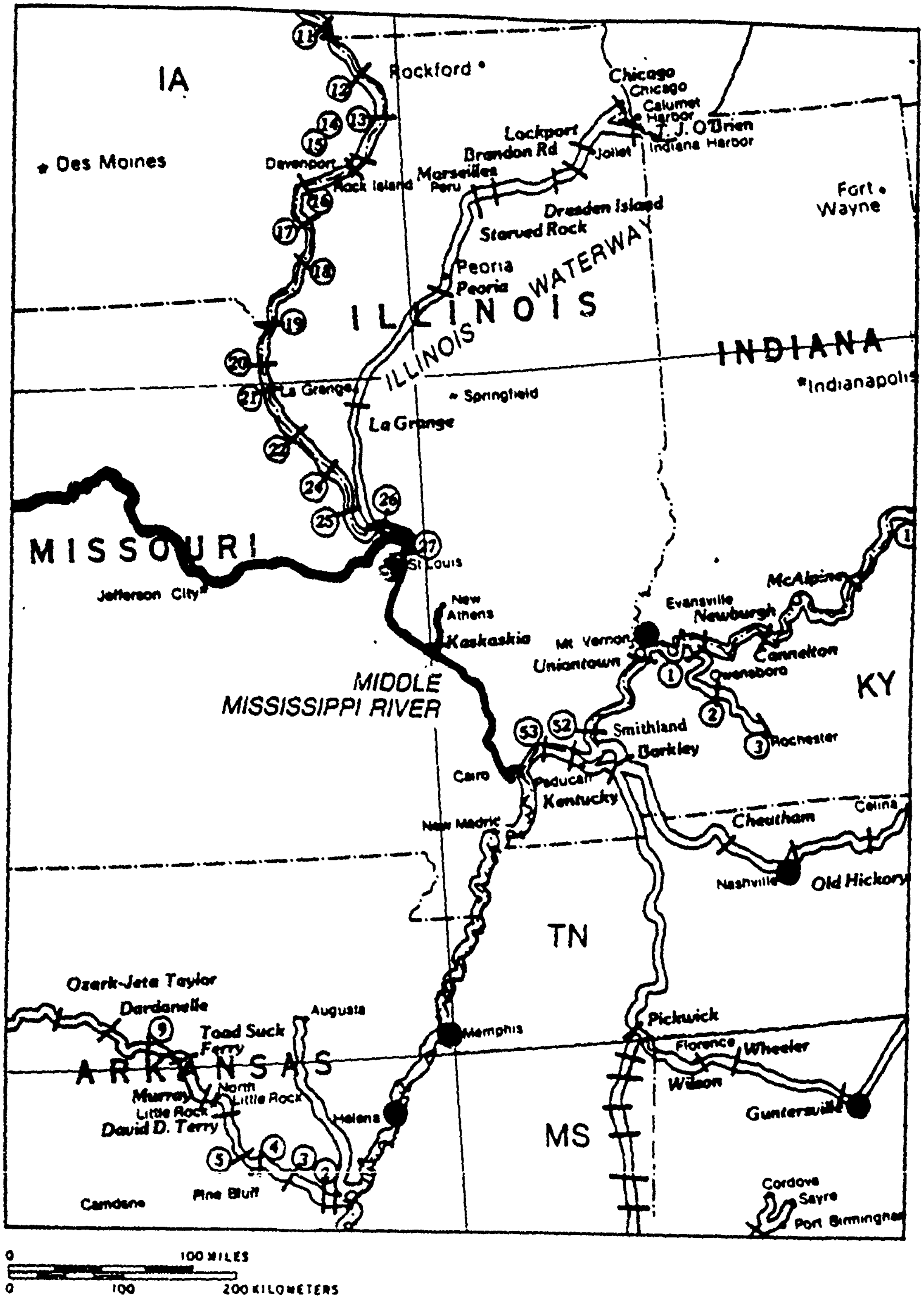


Figure A-2-1
Segment 2, Middle Mississippi

TABLE A-2-1
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
L&D 27 Main chamber	185.1	1953	35	110	1200	21
L&D 27 Aux. chamber	185.1	1953	35	110	600	21
Kaskaskia	0.8	1973	15	84	600	32

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986

TABLE A-2-2

SEGMENT NUMBER 2

MIDDLE MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
L&D 27 Mn. Chmb	82 (85)	49	39 (87)	39	118 (85)	88	13520 (85)	9125	65 (85)	62
Kaskaskia	58 (87)	58	31 (81)	25	83 (87)	83	289 (87)	289	13 (85)	11

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.

** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls

** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls

** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl

** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)

** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-2-2
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
L&D 27	835 (86)	213	1427 (80)	19	170 (81)	14	1532 (80)	246	53 (81)	38	34 (85)	17	173 (85)	30	123 (81)	85
Kaskaskia	1553 (87)	1553	367 (86)	0**	20 (83)	5	1558 (87)	1558	3 (87)	3	21 (85)	1	7 (86)	3	23 (85)	6

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.

** Zero indicates that no data is available.

*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-2-3A
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	28191	32733	30468	34585	34319	41470	42894	44275	46513	43380	33147	31955
Other Agricultural Prdcts	3500	5268	5320	6046	6810	8116	7225	7604	9395	7686	6690	8281
Metallic Ores	319	256	252	423	317	406	325	254	618	369	540	384
Coal	12714	11033	10680	8602	10654	14611	14390	13673	14027	20457	19637	21478
Crude Petroleum	219	860	752	787	360	507	472	577	1004	529	908	205
Non-Metlc Minerals & Prod	4750	5060	5035	5616	5310	5397	5072	5408	6418	7671	7904	8368
Lumber, Wood Prod. & Pulp	193	190	188	123	123	109	116	96	116	110	86	80
Industrial Chemicals	4042	3963	3831	3682	3549	3692	3492	3256	3111	3664	3676	4413
Agricultural Chemicals	3485	3574	3912	3965	3942	4011	4116	2696	4623	5736	5153	5606
Petroleum Prdcts	10177	10697	9577	9753	8977	8715	9019	8455	7655	7821	8042	8721
Metallic Products & Scrap	2769	3178	3027	3025	3291	3193	2914	2014	2533	2995	3166	3750
All Other Commodities	1099	1177	1264	2554	2671	2600	2139	2177	2712	3202	3719	4482
TOTAL	71458	77989	74306	79161	80323	92827	92174	90485	98725	103620	92668	97723

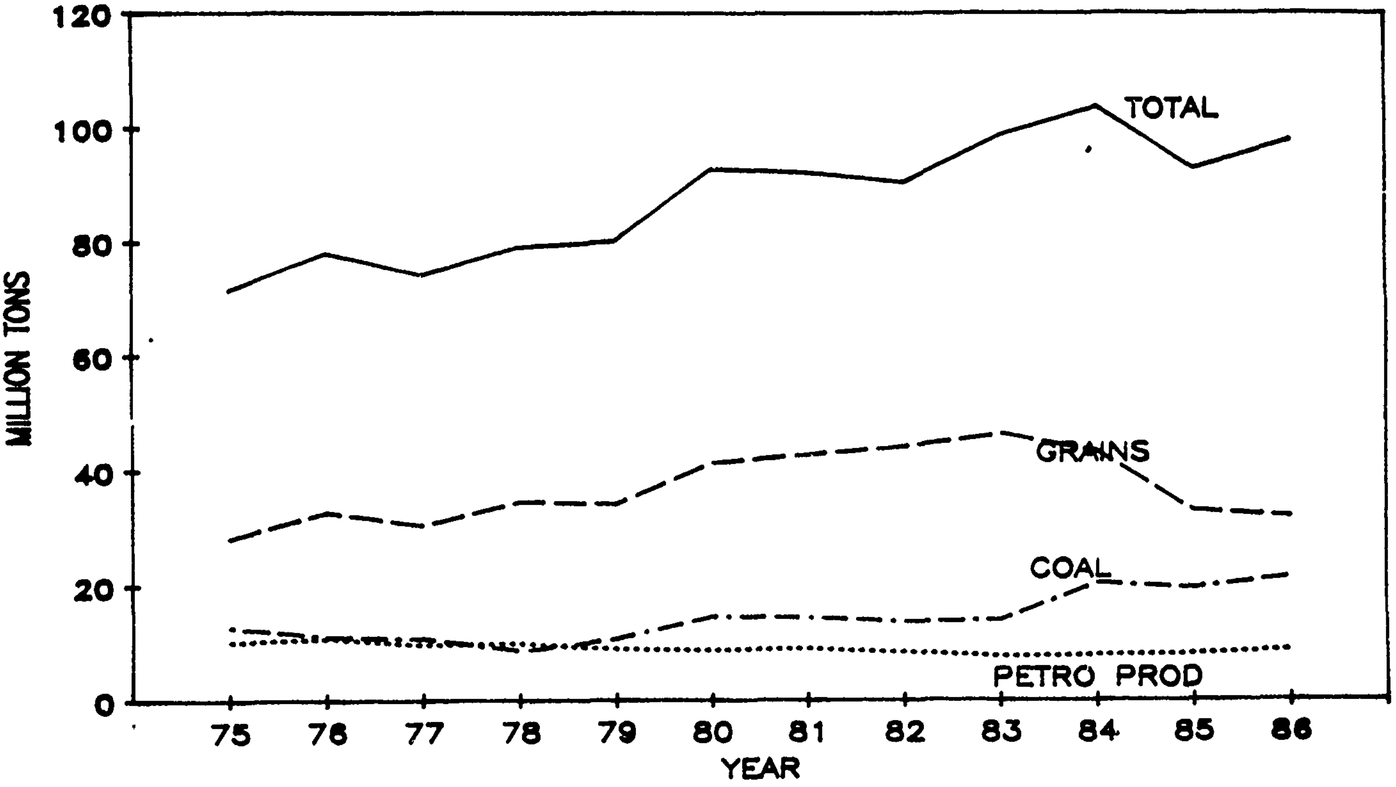
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

TABLE A-2-3B
SEGMENT NUMBER 2
MISSOURI RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	837	1113	1228	1288	1395	1099	969	1040	1153	873	771	533
Other Agricultural Prdcts	454	768	741	703	622	572	372	514	486	480	371	377
Metallic Ores	1	2	0	0	1	2	5	7	4	2	1	2
Coal	0	0	1	2	3	0	1	39	16	101	15	7
Crude Petroleum	0	0	0	1	0	0	0	0	0	0	0	0
Non-Metlc Minerals & Prod	3036	3202	3366	4114	4231	3002	2824	2496	3223	3418	3685	4460
Lumber, Wood Prod. & Pulp	9	3	9	8	11	10	7	7	7	6	6	10
Industrial Chemicals	76	50	59	85	72	46	38	43	28	48	49	57
Agricultural Chemicals	384	466	477	426	480	457	441	366	521	666	639	636
Petroleum Prdcts	212	281	436	258	176	316	216	171	272	283	360	333
Metallic Products & Scrap	45	88	87	126	125	117	187	85	87	185	98	33
All Other Commodities	1154	580	331	918	569	294	192	113	505	324	476	476
TOTAL	6208	6553	6735	7929	7685	5915	5252	4881	6302	6386	6471	6991

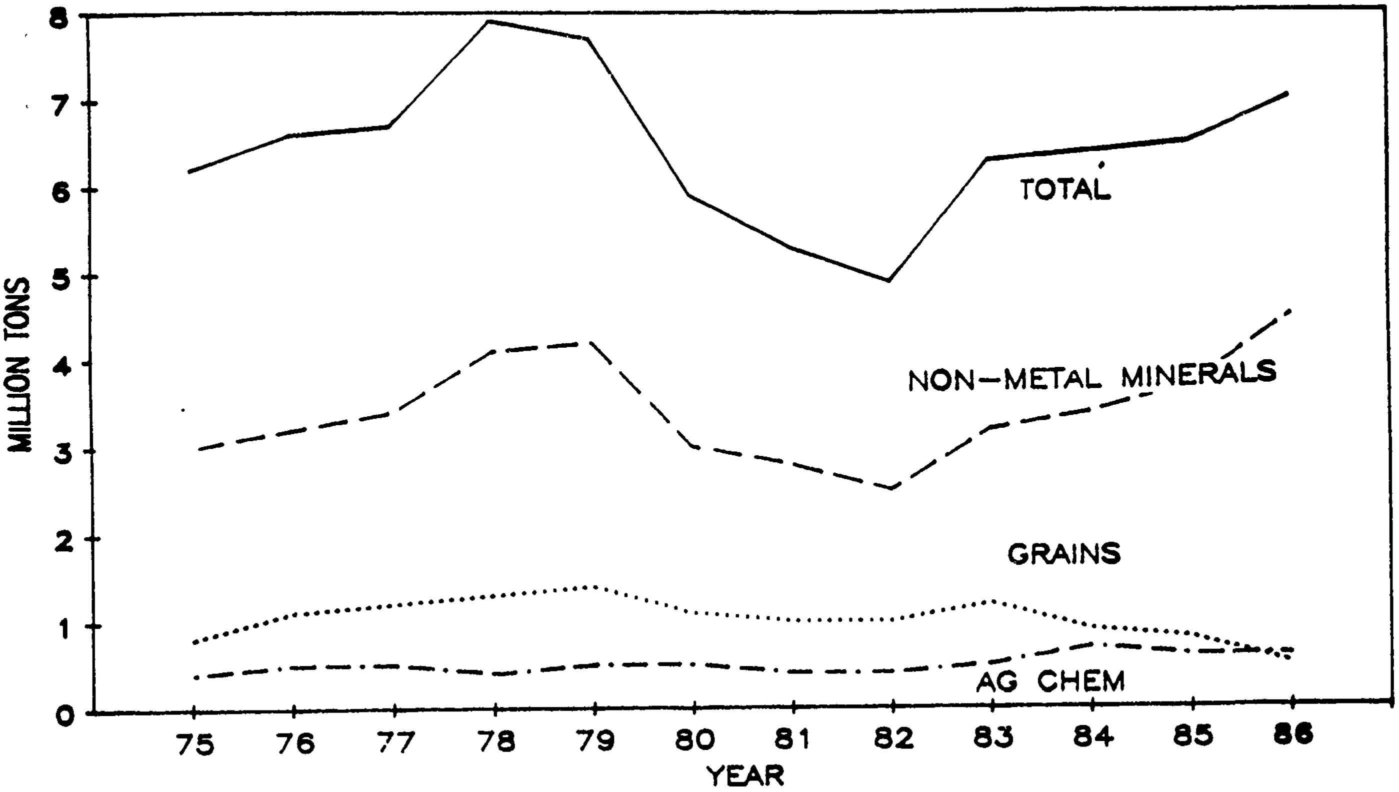
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-2-2A
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



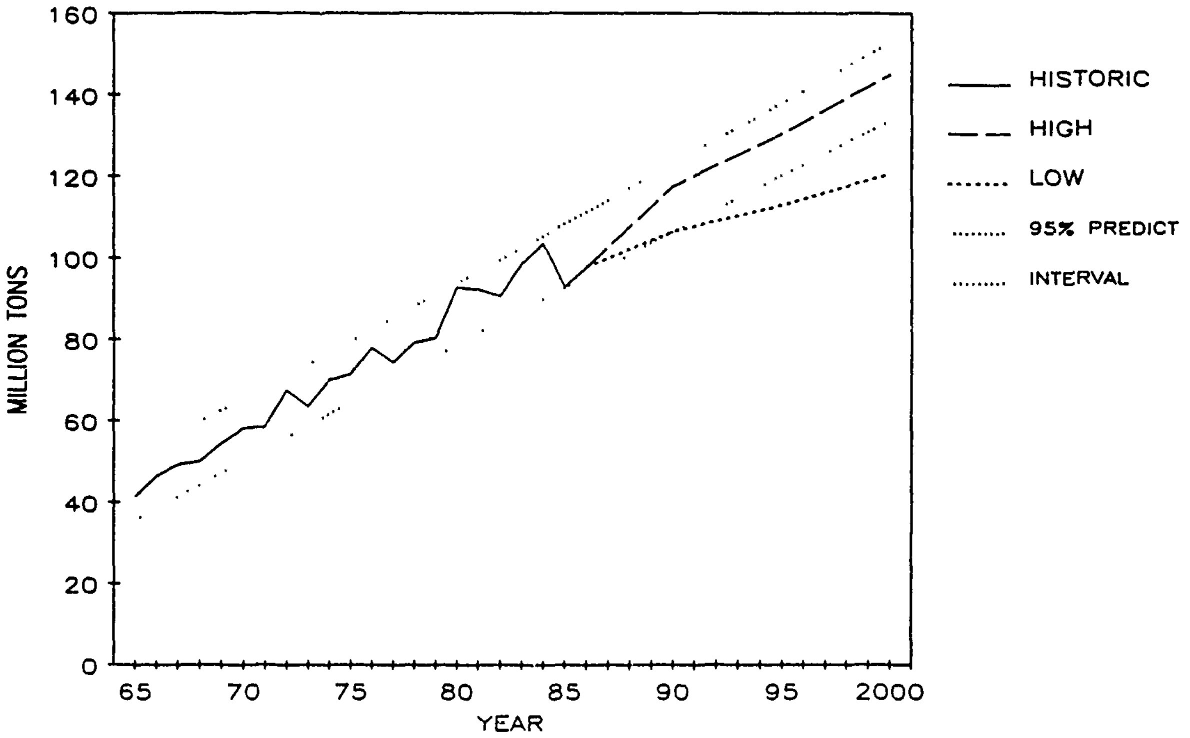
GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-2-2B
SEGMENT NUMBER 2
MISSOURI RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



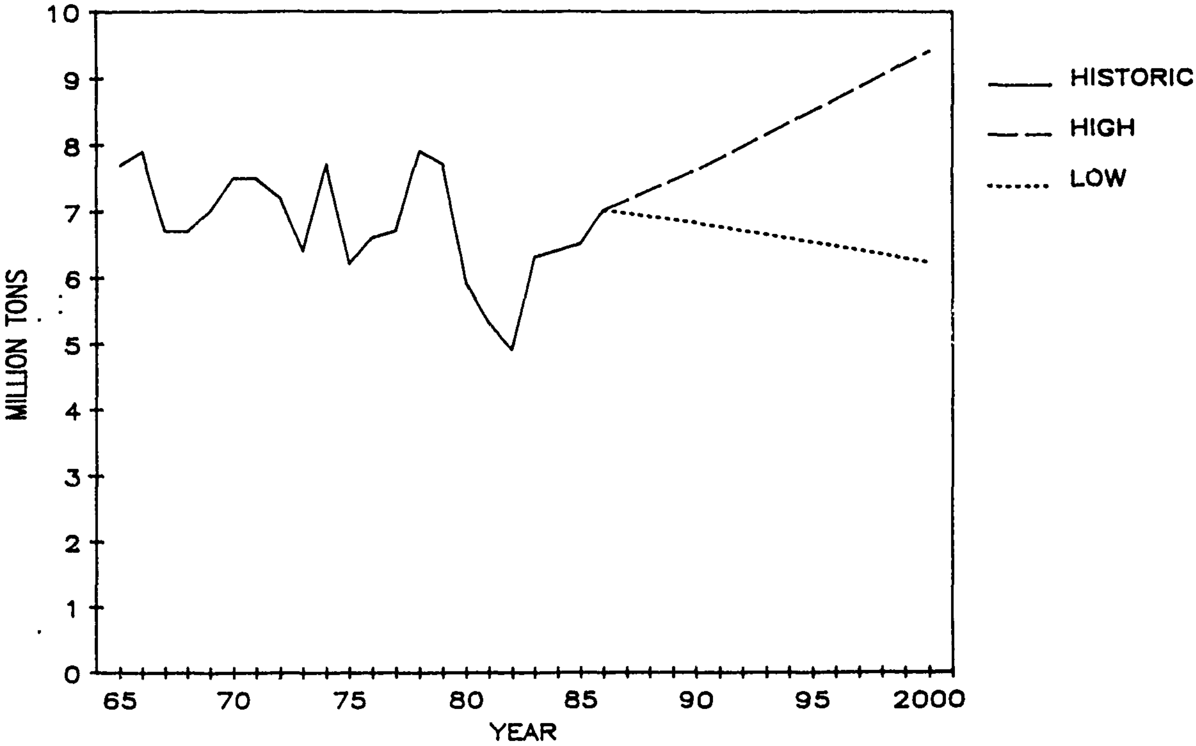
GRAPHED BY CEWRC-IWR. DATA SOURCE: WATERBORNE COMMERCE OF THE U.S. (ANNUAL)

FIGURE A-2-3A
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

FIGURE A-2-3B
SEGMENT NUMBER 2
MISSOURI RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-2-4
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
L&D 27	64.2	2.0%	65.0	68.3	78.0	23.4	54.6	8.8	9.0	10.1	5.0	5.1	7.4	7.6	7.7	7	7	8
Kaskaskia	1.3	9.1%	3.8	4.0	3.1	0.1	3.0	1.5	1.5	1.2	0.6	0.6	2.5	2.7	2.5	3	3	3

N.A. = NOT AVAILABLE
SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-2-5
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENENCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MDL MISS R										
Mo R-Oh R	13,037	9,603	5,440	9,619	8,563	9,144	10,176	7,170	12,188	9,765
Missouri R	3,617	3,280	3,824	3,695	3,605	3,955	4,201	3,710	6,570	5,581
Kaskaskia R	852	593	1,237	982	1,284	1,238	1,360	1,311	1,784	1,599
Subtotal	17,506	13,476	10,501	14,296	13,452	14,337	15,737	12,191	20,542	16,945

TON MILES OF TRAFFIC (000) CY 1977-1986

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MDL MISS R										
Mo R-Oh R	12,389,978	13,424,160	13,631,377	15,978,012	15,900,660	15,589,375	17,145,535	17,713,497	15,589,939	16,359,364
Missouri R	1,596,284	1,528,614	1,518,549	1,335,309	1,130,787	1,131,249	1,050,149	1,338,939	1,201,854	1,044,299
Kaskaskia R	31,789	42,432	42,918	51,094	67,575	79,951	62,581	80,866	74,212	101,008
Subtotal	14,018,051	14,995,206	15,192,844	17,364,415	17,099,022	16,800,575	18,258,265	19,133,302	16,866,005	17,504,671

O & M COSTS PER TON MILE ($) 1977-1986

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MDL MISS R										
Mo R-Oh R	0.0011	0.0007	0.0004	0.0006	0.0005	0.0006	0.0006	0.0004	0.0008	0.0006
Missouri R	0.0023	0.0021	0.0025	0.0028	0.0032	0.0035	0.0040	0.0028	0.0055	0.0053
Kaskaskia R	0.0268	0.0140	0.0288	0.0192	0.0190	0.0155	0.0217	0.0162	0.0240	0.0158
Segment	0.0012	0.0009	0.0007	0.0008	0.0008	0.0009	0.0009	0.0006	0.0012	0.0010

NOTE: FY 1987 costs in order by the waterway(s) above are 12,540, 7,152, and 1,689, respectively and the subtotal is 21,381 1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available. The increased costs for the Missouri River due in part to a change in cost allocation for this river that assigned 44 percent rather than 10 percent of joint costs to navigation.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.
*1983 Ton-mile value is an estimate.

TABLE A-2-6
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
MISSISSIPPI RIVER								
Regulating Works	CCF	1910	2000	187,000	0	118,445	63	4,400
MISSOURI RIVER								
Yankton to Mouth	SANS	Unk	Unk	2,355	0	13	1	0

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-2-7
SEGMENT NUMBER 2
MIDDLE MISSISSIPPI RIVER

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
L&D 27	1953	169	187	64.2	65.0	68.3	78.0	1.0	6.4	21.5	46.2%	41.7%	62
Kaskaskia	1973	30	35	1.3	3.8	4.0	3.1	193.0	207.7	138.5	10.3%	8.9%	11

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 3
LOWER MISSISSIPPI

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-3-1). This segment includes six waterways.

(1) The Lower Mississippi River extends from the mouth of the Ohio River at Cairo, Illinois, to Baton Rouge, Louisiana (725 miles). Channel size and river conditions for the Lower Mississippi River differ markedly from that of its five tributaries. It has an authorized project channel depth of twelve feet that has been constructed and maintained to nine feet and a project width of 300 feet. River stages vary with discharge throughout the year, and can vary as much as 30 to 40 feet during the year. Shoals usually develop in the late summer and early fall, requiring dredging to maintain channel dimensions. River velocities as well as channel location also vary with discharge. The river drops gently about 280 feet in elevation from Cairo to Baton Rouge or slightly less than 2/5 of a foot per mile.

(2) The McClellan-Kerr Arkansas River Navigation System extends from Catoosa, Oklahoma, on the Verdigris River to the waterway's junction with the Mississippi River (450 miles). The Arkansas system includes the lower most 10 miles of the White River. The Arkansas system has a project depth of nine feet and project widths of 250 feet on the Arkansas River, 150 feet on the Verdigris River for 50 miles, and 300 feet in the White River, Arkansas Post Canal, which connects the White and Arkansas Rivers, and the short tributary San Bois Creek.

(3) The White River extends from Newport, Arkansas, to its junction with the Arkansas system (245 miles). The White River is maintained at a minimum width of 125 feet and depth of five feet, but eight feet when the stage reaches twelve on the Clarendon gauge, from the Arkansas system (mile 10) to Augusta (mile 199) and a minimum width of 100 feet and depth of 4.5 feet from the Augusta to Newport.

(4) The Ouachita and Black Rivers extends from Camden, Arkansas, to the junction with the Red River in Louisiana (350 miles). The project channel is nine feet deep and 100 feet wide.

(5) The Red River project now under construction extends from Shreveport, Louisiana, to its junction with the Atchafalaya River (236 miles) six miles west of the Mississippi River. The Red River project is authorized for a channel nine feet deep and 200 feet wide. An interim pool level of 58 feet is providing a nine foot depth to Alexandria (mile 105).

(6) The Atchafalaya River extends from its junction with the Mississippi River about seventy-six miles above Baton Rouge to its junction with the Gulf Intracoastal Waterway at Morgan City, Louisiana (121 miles). The Red and Atchafalaya Rivers share a six mile long common channel called the Old River immediately west of their junction with the Mississippi River. The Atchafalaya River project channel, including the six mile Old River is twelve feet deep and 125 feet wide.

(7) The Yazoo River extends from Greenwood, Mississippi, to its junction with the Mississippi River at Vicksburg, Mississippi (165 miles). The Yazoo River is an open river with no maintained depths or widths. It is severely restricted by low water periods of less than nine foot depth, numerous sharp bends, overhanging trees, and snags that permit river vessels to reach Greenwood only about 45 percent of the time. Traffic on the river is not subject to inland waterway fuel tax.

b. Locks (Table A-3-1). There are no locks on the Lower Mississippi River, the White River, or Yazoo River, but there are locks on the Arkansas system, Ouachita and Black Rivers, Red River, and Atchafalaya River. The 17 locks on the Arkansas system are 600 feet long and 110 feet wide and 18-21 years old . They provide a total lift of 420 feet with individual lifts ranging from 15 to 55 feet. The four locks on the Ouachita and Black Rivers are 600 feet long and 84 feet wide and their lift ranges from 12 to 30 feet. Two are 4 years old and two are 16 years old. The Atchafalaya River's 24 year old Old River Lock is 1200 by 75 feet with a 35 foot lift. A 600 by 84 foot lock and dam on the Yazoo River near Vicksburg was authorized in 1968, but has not been constructed.

2. PERFORMANCE CHARACTERISTICS (Table A-3-2).

Data are unavailable for the waterway for 1987. However, the total peak average processing time for the 1980-1987 time period ranged from 24 minutes (1984) at locks Felsenthal and Thatcheron the Ouachita-Black Rivers to 117 minutes or 1.95 hours at L&D 3 (1982) on the Arkansas River. In this segment, the highest total peak average processing time from 1980 through 1987, was for L&D 3 on the Arkansas Navigation System in 1982 (117 minutes or 1.95 hours). The peak total delay for the 1980-1987 time period ranged from 5 hours (1981) for Columbia to 1677 hours (1983) for L&D 2 on the Arkansas Navigation System. The highest peak total delay for the 1980-1987 time period occurred in 1983 for L&D 2 with a total delay of 1677 hours. The peak utilization data for 1980-1987 ranged from 8% (1981) for Jonesville to 28% (1987) for Old River. In this segment, the highest peak utilization for the 1980-1987 time period was 28% in 1987 for Old River. The peak total downtime ranged from 0 hours for Felsenthal and Thatcher locks to 1467 hours in 1982 for L&D 3 on the Arkansas Navigation System in 1982. L&D 3 had the highest peak total downtime hours 1467 hours. The peak for total number of stall events ranged from 1 in Felsenthal and Thatcher (1984 and 1985, respectively) to 64 (1980) for Robert S. Kerr. The highest total peak stall events was for Robert S. Kerr in 1980 (64 events).

3. COMMODITY TRAFFIC (Tables A-2, A-3-3A,-3B,-4); (Figures A-3-2A,-2B,-3A, -3B).

a. Historical. The Lower Mississippi River between the mouth of the Ohio and deep water at Baton Rouge, funnels waterborne commerce between most other inland waterways and the ports of the Gulf Coast. Being a wide, open river with no locks, the Lower Mississippi allows the movement of tows with 40 or more barges, resulting in very low costs per ton for the shipment of huge cargoes. Barge traffic on the main stem of the Lower Mississippi grew from 108.6 million tons in 1975 to a peak of 156.6 million in 1984. Tonnage fell somewhat in 1985 to 149.9 million tons before recovering to near record levels

again in 1986, with 156.2 million tons. As in other sections of the Mississippi, farm products account for the largest share of traffic (52 percent in 1982 and 36 percent in 1986). Grains and oilseeds, such as wheat, corn, and soybeans, make up the bulk of the farm products traffic. Grain tonnage grew from 33 million in 1975 to a peak of 62.2 million in 1982. Due to falling exports, grain traffic declined to 43.3 million tons in 1986. Substantial recovery of this traffic occurred in 1987 with the surge in grain export sales, although complete data is not yet available. Coal tonnage is also significant, growing substantially from 11.4 million in 1975 to a 1986 peak of 32.5 million. The importance of petroleum and the petrochemical industry in the Gulf Coast area is also reflected in traffic on the Lower Mississippi. Although tonnage in these commodities has generally declined over the last decade a rebound occurred in 1986. Petroleum products traffic peaked in 1978 at 25.1 million tons before declining to a 1985 low of 14.8 million. Tonnage increased to 18 million in 1986. Industrial chemicals traffic has varied between a low of 9.2 million tons in 1975 and a high of 12.2 million tons in 1986. Movements of other agricultural products have increased from 5.5 million tons in 1975 to a peak of nearly 14 million tons in 1983, then declined to 11.1 million tons in 1985, before recovering to 13.5 million tons in 1986. Much of this tonnage is in processed grain products and animal feeds for export. Movements of non-metallic minerals have been cyclical, but generally increasing over time. This traffic amounted to 11.6 million tons in 1986, up from 7.4 million in 1975.

Traffic on the McClellan-Kerr Arkansas River Navigation System grew steadily from 5.2 million tons in 1975 to a peak of nearly 9.9 million in 1978. Since then it has varied between 7.7 million tons in 1981 and 8.5 million in 1984. Traffic in 1986 was 8.4 million tons. The primary commodities include non-metallic minerals and products, grains and oilseeds, and agricultural chemicals. Non-metallic mineral tonnage peaked in 1978 at nearly 3 million tons, declined to a 1982 low of 1.6 million before recovering by 1986 to 2.7 million tons.

Traffic on other tributaries of the Lower Mississippi River in 1986 totalled 7.3 million tons on the Atchafalaya River, 2.7 million tons on the Red River, 0.8 million tons on the Ouachita-Black Rivers, and 0.5 million tons on the White River, and 0.4 million tons on the Yazoo.

b. Forecast. Waterborne commerce on the Lower Mississippi Segment is projected to grow from 156.2 million tons to between 189.5 and 234.0 million tons by 2000. Farm products accounted for 36 percent of all tons in 1986 and greatly influence future traffic forecasts. Recent fluctuations in grain export movements make this commodity group a difficult one to predict and help explain the wide difference in projections by 2000.

Between 1986 and 2000, waterborne commerce on the Arkansas River is projected to increase from 8.4 million tons to between 9.6 and 15.5 million tons by 2000. Nonmetallic minerals and products (mostly sand and gravel) farm products are the principal commodities influencing the projections.

c. Tonnage at Locks. Based on average annual percent change during the period of 1977-1986, tonnage increase at individual locks varied from 1.2% (L&D 3) to 9.1% (Newt Graham) on the Arkansas River. (Lock tonnage figures for the Arkansas River for 1987 were not available at the time of this writing).

The actual tonnage for 1986 or Arkansas River ranged from 2.4 million tons (Newt Graham) to 5.8 million tons (L&D 2). Total increase in percent for 1977-86 period ranged from 10% (L&D 3) to 100% (Newt Graham).

4. OPERATION AND MAINTENANCE COSTS (Table A-3-5).

O&M costs in actual dollars for the Lower Mississippi River Segment increased from about $50 million to about $84 million in 1986. That was a 0% increase in real terms when adjusted for about 68% inflation during the same period. This level of expenditure constituted about 25% of total expenditure for all segments during the period. Traffic increased from about 75 billion ton-miles in 1977 to about 100 billion ton-miles in 1986. O&M cost per ton-mile was the lowest of all nine segments, and ranged from 0.7 mills in 1977 to .8 mills in 1986.

5. PROGRAM STATUS (Table A-3-6).

a. Overview. There are eight authorized construction projects in the Lower Mississippi River Segment, but construction has not started on three of them. There are six basin multiple purpose studies now underway considering improvements to the existing navigation system or extension of it.

b. Mississippi River. The comprehensive project for Flood Control, Mississippi River and Tributaries (MR&T), provides flood damage reduction and improvement of the Mississippi River for navigation from Cairo, Illinois, to Baton Rouge, Louisiana. The Mississippi River channel improvement project includes dikes, revetments, dredging, and foreshore protection. The $3,076.3 million project is scheduled to be completed in 2010. Only nine feet of the 12 foot deep channel authorized in 1944 has been constructed. The project is fiscally 54 percent complete and will be 55 percent complete with funds requested for FY 1989. However, it is physically 80 percent complete. Work in 1988 and 1989 will be used to extend existing revetments and assure continued effectiveness of completed work at 48 locations (88 percent of funds) and to construct dikes at 24 locations.

c. Arkansas Navigation System.

(1) The entire project will be complete in 1990 at a cost of $563.3 million after completion of rock excavation at Murray Lock and Dam pool and construction of a meander cutoff level in the entrance channel for $7.6 million. A model study completed in 1987 of scouring at Wilbur D. Mills Dam (No. 2) indicated the need to extend the stilling basin downstream at an additional project cost of $7.8 million. A model study completed in March 1988 of low water at the White River entrance channel indicates the need to construct an additional lock and dam in the entrance channel. Planning studies are scheduled for completion in 1990.

(2) There are three basin multiple purpose studies that include navigation. The $2.5 million Arkansas River Basin study, scheduled for completion in 1990, is considering navigation operation problems related to the magnitude and duration of flows above 75,000 cubic feet per second at James W. Trimble Lock and Dam. Solutions may involve possible changes in system operation and additional storage to further control flood flows. The $7.3 million Arkansas River and Tributaries, Great Bend, Kansas, to Tulsa, Oklahoma, study is scheduled for completion in 1991. Studies to date show

that costs for extending navigation upstream of Tulsa would exceed benefits, and the navigation extension studies have been suspended. The $2.1 million Arkansas River and tributaries, South Central and Southeast Areas of Oklahoma, Comprehensive Study being completed in September 1988 is considering measures for extension of navigation into the Poteau and Deep Fork Rivers along with other water resource problems and needs.

d. Ouachita and Black Rivers.

(1) Construction of the nine foot deep, 100 foot wide channel with four 600 by 84 foot locks began in 1963 and is scheduled for completion in 1994. The $247.7 million, 382 mile long waterway project is 83 percent complete this year and with funds requested for FY 1989. Work scheduled for 1988 and 1989 includes navigation channels in all four pools and the hinged crest gate at Felsenthal Lock and Dam.

(2) The Ouachita River Basin $8.6 million study addressing problems and needs of navigation and other water resource purposes now has an indefinite completion date.

e. White River. The $32.0 million project was authorized in 1986 to provide a nine foot navigation channel 95 percent of the times from mile 10 (junction with the Arkansas River System) to mile 254 (Newport) through dredging, channel training works, bank stabilization, and other improvements. None of the preconstruction engineering and design costing $2.2 million has been accomplished nor is any scheduled for 1989 through 1993.

f. Red River.

(1) Construction on the $1,731.9 million project from the Mississippi River to Shreveport, Louisiana, resulted in the opening in 1987 of Overton Lock and Dam, thereby extending nine foot navigation to Alexandria (mile 105). Construction of Lock and Dam No. 3 at Colfax (mile 141) started in 1985 and navigation is now 28 percent complete. It is scheduled to open in 1991. On Pools 4 and 5 construction (8 percent complete) and accelerated design continues. Design of Locks and Dams 4 and 5 is also being accelerated. Completion of Locks, Dams, and Pools 4 and 5 is indefinite pending a decision to schedule remaining construction. The entire 236 mile long waterway project with five 685 by 84 foot locks is 51% complete and will be 58 percent complete 1with the funds requested for FY 1989.

(2) Construction of the authorized $656.6 million project to extend navigation from Shreveport to Daingerfield, Texas, has not started. In the mid-1970s preconstruction studies were begun and then deferred until warranted by development of traffic on the river below Shreveport. The project would include 9 foot deep and 200 foot wide channel, three dams (two existing), and three 600 by 84 foot locks.

(3) The $3.1 million Red River Basin Comprehensive Study considering measures for development of navigation and other purposes has been divided into two studies, one on the upper river and one on the lower river. In FY 1989 the $0.5 million reconnaissance phase of a Red River Basin comprehensive study within Arkansas and Louisiana would be initiated and completed. The $1.9 million multiple purpose study of the Red River, Denison Dam - Lake Texoma, in Oklahoma and Texas is 82 percent complete and will be completed in 1990.

g. Atchafalaya River. The Atchafalaya Basin project includes channels, locks, and bank stabilization that benefit navigation and other purposes. The $1,468 million project, part of the overall MR&T project, is scheduled for completion in 2010. It is fiscally 41 percent complete and will be 44 percent complete with funds requested for FY 1989. However, it is physically 74 percent complete. Work in 1988 and 1989 includes raising the most deficient sections of lever and flood walls, providing necessary bank stabilization, and providing channel training works above Morgan City.

h. Yazoo River (Non Fuel Taxed Waterway). Construction of the $237 million Yazoo River project authorized in 1968 has not started, but preconstruction studies began 1978 and then were deferred in 1985. The project would provide a 9 foot channel to Greenwood, Mississippi, through construction of a 600 by 84 foot lock and dam at the mouth near Vicksburg, channel realignment and dredging, and reservoir releases.

6. LOCK CAPACITY CHARACTERISTICS (Table A-3-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-3-4.

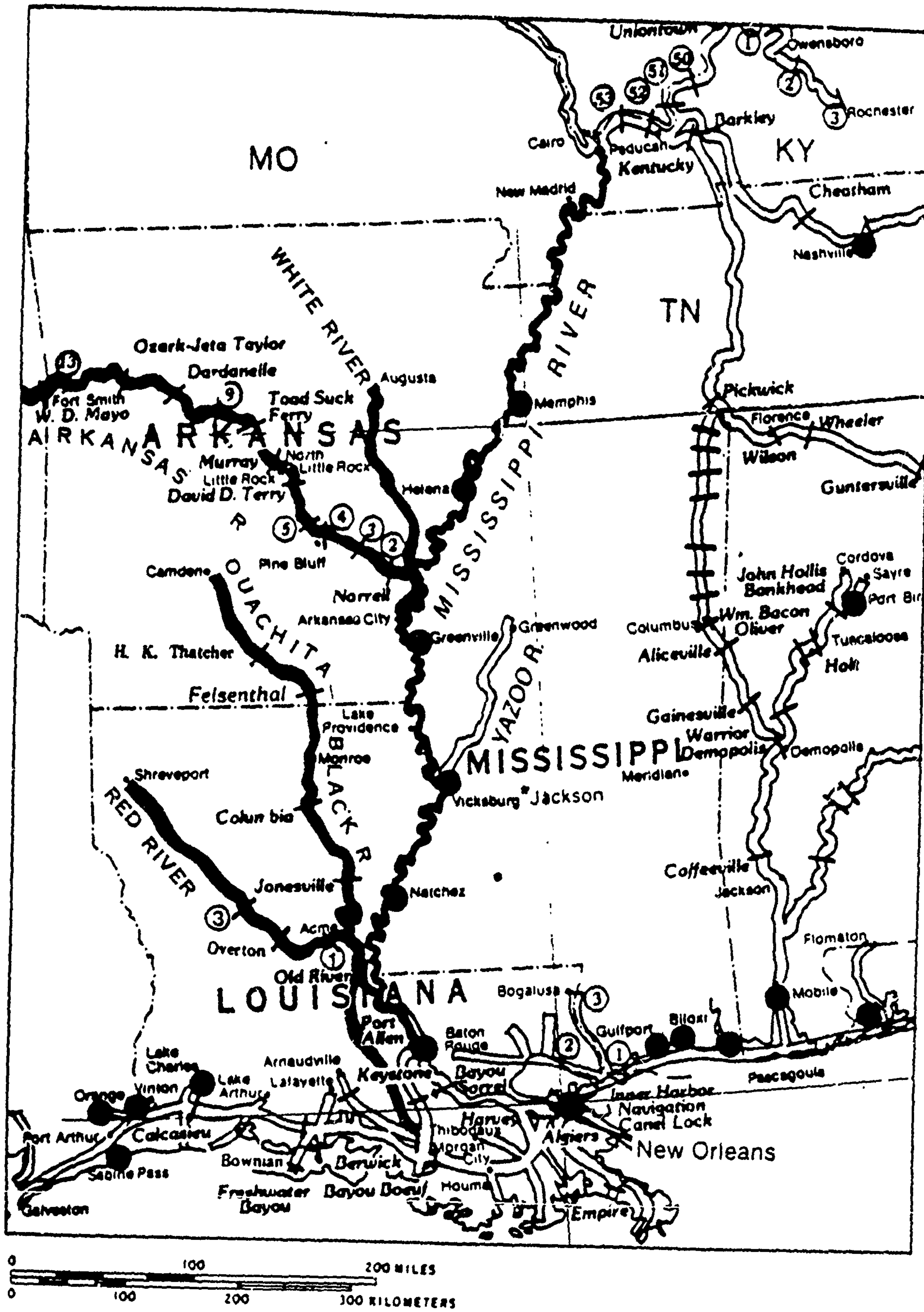


Figure A-3-1
Segment 3, Lower Mississippi

TABLE A-3-1
SEGMENT NUMBER 3
LOWER MISSISSIPPI

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Arkansas River						
Norrell	10.3	1967	21	110	600	30
Lock 2 & Mills Dam	13.3	1967	21	110	600	20
L&D 3	50.2	1968	20	110	600	20
L&D 4	66.0	1968	20	110	600	14
L&D 5	86.3	1968	20	110	600	17
David T. Terry	108.1	1968	20	110	600	18
Murray	125.4	1969	19	110	600	18
Toad Suck	155.9	1969	19	110	600	16
Ormond	176.9	1969	19	110	600	20
Dardanelle	205.5	1969	19	110	600	55
Ozark	256.8	1969	19	110	600	34
James W. Trimble	292.8	1969	19	110	600	20
W.D. Mayo	319.6	1970	18	110	600	21
Robert S. Kerr	336.2	1970	18	110	600	48
Webbers Falls	366.6	1970	18	110	600	30
Chouteau (Verd. R)	401.5	1970	18	110	600	21
Newt Graham (Verd. R)	421.6	1970	18	110	600	21
Ouachita & Black Rivers						
Jonesville	25.0	1972	16	84	600	30
Columbia	117.2	1972	16	84	600	18
Felsenthal	226.8	1984	4	84	600	18
Thatcher	281.7	1984	4	84	600	12
Red River						
L&D 1	43.0	1984	4	84	685	36
Overton	87.0	1987	0	84	685	24
L&D 3 (Under Const.)	141.0	Indef	--	84	685	31
Atchafalaya (Old) River						
Old River	304.0	1963	25	75	1200	35

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

TABLE A-3-2

SEGMENT NUMBER 3

LOWER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK* (PEAK YEAR)	AVERAGE PROCESSING TIME PER TOW						TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	DELAY** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)					
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Arkansas Nav. Sys.										
Norrell	7 (80)	N.A.	43 (84)	N.A.	50 (80)	N.A.	213 (81)	N.A.	20 (86)	N.A.
L&D 2	63 (83)	N.A.	49 (84)	N.A.	109 (83)	N.A.	1677 (83)	N.A.	22 (86)	N.A.
L&D 3	68 (82)	N.A.	53 (81)	N.A.	117 (82)	N.A.	1641 (82)	N.A.	22 (81)	N.A.
L&D 4	27 (83)	N.A.	50 (83)	N.A.	77 (83)	N.A.	575 (83)	N.A.	19 (85)	N.A.
L&D 5	5 (83)	N.A.	54 (81)	N.A.	59 (81)	N.A.	129 (81)	N.A.	21 (86)	N.A.
David T. Terry	7 (82)	N.A.	51 (83)	N.A.	59 (81)	N.A.	179 (81)	N.A.	23 (86)	N.A.
Murray	6 (82)	N.A.	48 (82)	N.A.	54 (82)	N.A.	126 (81)	N.A.	21 (85)	N.A.
Toad Suck	5 (83)	N.A.	49 (80)	N.A.	66 (86)	N.A.	371 (86)	N.A.	19 (86)	N.A.
Ormond	6 (82)	N.A.	56 (83)	N.A.	61 (83)	N.A.	128 (81)	N.A.	18 (85)	N.A.
Dardanelle	46 (83)	N.A.	53 (83)	N.A.	99 (83)	N.A.	770 (83)	N.A.	19 (85)	N.A.
Ozark	9 (83)	N.A.	54 (83)	N.A.	63 (83)	N.A.	161 (81)	N.A.	18 (85)	N.A.
L&D 13	7 (83)	N.A.	52 (83)	N.A.	59 (83)	N.A.	151 (85)	N.A.	21 (86)	N.A.
W. D. Mayo	7 (80)	N.A.	49 (84)	N.A.	55 (81)	N.A.	121 (80)	N.A.	22 (86)	N.A.
Robert S. Kerr	55 (84)	N.A.	54 (83)	N.A.	107 (84)	N.A.	828 (84)	N.A.	25 (86)	N.A.
Webbers Falls	17 (86)	N.A.	64 (82)	N.A.	72 (86)	N.A.	183 (86)	N.A.	27 (86)	N.A.
Chouteau (Verd R)	3 (84)	N.A.	51 (80)	N.A.	53 (81)	N.A.	44 (82)	N.A.	23 (86)	N.A.
Newt Grham(Verd R)	13 (85)	N.A.	54 (81)	N.A.	64 (85)	N.A.	147 (85)	N.A.	23 (86)	N.A.

TABLE A-3-2 (CONTINUED)
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW						TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	DELAY** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)					
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Ouachita & Black R.										
Jonesville	3 (84)	N.A.	42 (83)	N.A.	44 (84)	N.A.	24 (80)	N.A.	8 (81)	N.A.
Columbia	1 (84)	N.A.	44 (82)	N.A.	45 (81)	N.A.	5 (81)	N.A.	25 (86)	N.A.
Felsenthal	4 (84)	N.A.	20 (84)	N.A.	24 (84)	N.A.	9 (85)	N.A.	12 (84)	N.A.
Thatcher	4 (84)	N.A.	20 (84)	N.A.	24 (84)	N.A.	5 (85)	N.A.	14 (84)	N.A.
Red River										
L&D 1	15 (86)	N.A.	27 (86)	N.A.	42 (86)	N.A.	203 (85)	N.A.	13 (85)	N.A.
Overton (u. const.)		LOCK		NOT	OPERATIONAL					
L&D 3 (u. const.)		LOCK		NOT	OPERATIONAL					
Atchafalaya (Old) R.										
Old River	27 (87)	27	36 (87)	36	63 (87)	63	1349 (87)	1349	28 (87)	28

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-3-2

SEGMENT NUMBER 3

LOWER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Arkansas Nav. Sys.																
Norrell	2 (85)	N.A.	15 (81)	N.A.	15 (81)	N.A.	31 (81)	N.A.	3 (85)	N.A.	5 (80)	N.A.	14 (81)	N.A.	18 (80)	N.A.
L&D 2	17 (85)	N.A.	24 (81)	N.A.	49 (83)	N.A.	55 (83)	N.A.	10 (85)	N.A.	7 (81)	N.A.	21 (80)	N.A.	23 (85)	N.A.
L&D 3	1 (81)	N.A.	13 (84)	N.A.	1466 (82)	N.A.	1467 (82)	N.A.	1 (86)	N.A.	5 (84)	N.A.	15 (80)	N.A.	13 (82)	N.A.
L&D 4	9 (84)	N.A.	19 (82)	N.A.	232 (86)	N.A.	237 (86)	N.A.	3 (86)	N.A.	4 (82)	N.A.	14 (82)	N.A.	18 (82)	N.A.
L&D 5	3 (81)	N.A.	4 (81)	N.A.	5 (81)	N.A.	12 (81)	N.A.	4 (81)	N.A.	2 (81)	N.A.	5 (80)	N.A.	9 (81)	N.A.
David T. Terry	7 (85)	N.A.	1 (86)	N.A.	10 (80)	N.A.	13 (80)	N.A.	2 (86)	N.A.	1 (86)	N.A.	14 (80)	N.A.	16 (80)	N.A.
Murray	2 (82)	N.A.	6 (82)	N.A.	9 (82)	N.A.	17 (82)	N.A.	3 (82)	N.A.	2 (82)	N.A.	14 (80)	N.A.	9 (82)	N.A.
Toad Suck	0**	N.A.	7 (80)	N.A.	7 (84)	N.A.	8 (80)	N.A.	0	N.A.	6 (80)	N.A.	2 (84)	N.A.	7 (80)	N.A.
Ormond	1 (85)	N.A.	9 (82)	N.A.	12 (83)	N.A.	14 (82)	N.A.	1 (85)	N.A.	2 (84)	N.A.	11 (81)	N.A.	10 (81)	N.A.
Dardanelle	1 (84)	N.A.	0	N.A.	6 (82)	N.A.	6 (83)	N.A.	1 (84)	N.A.	0	N.A.	7 (82)	N.A.	7 (82)	N.A.
Ozark	0	N.A.	4 (82)	N.A.	14 (80)	N.A.	1 (85)	N.A.	0	N.A.	2 (82)	N.A.	4 (81)	N.A.	4 (81)	N.A.
L&D 13	6 (84)	N.A.	16 (83)	N.A.	33 (83)	N.A.	49 (83)	N.A.	4 (85)	N.A.	5 (83)	N.A.	15 (83)	N.A.	20 (83)	N.A.
W. D. Mayo	1 (82)	N.A.	32 (82)	N.A.	9 (81)	N.A.	41 (82)	N.A.	3 (82)	N.A.	8 (82)	N.A.	13 (81)	N.A.	19 (82)	N.A.
Robert S. Kerr	1 (83)	N.A.	20 (84)	N.A.	754 (84)	N.A.	774 (84)	N.A.	2 (85)	N.A.	12 (84)	N.A.	61 (80)	N.A.	64 (80)	N.A.
Webbers Falls	2 (86)	N.A.	13 (81)	N.A.	12 (84)	N.A.	25 (81)	N.A.	5 (84)	N.A.	8 (84)	N.A.	19 (84)	N.A.	31 (84)	N.A.
Chouteau (Verd.R.)	1 (82)	N.A.	6 (83)	N.A.	2 (86)	N.A.	6 (83)	N.A.	1 (82)	N.A.	5 (82)	N.A.	3 (82)	N.A.	9 (82)	N.A.
Newt Graham (Verd. R.)	18 (86)	N.A.	113 (85)	N.A.	18 (80)	N.A.	123 (85)	N.A.	15 (80)	N.A.	14 (84)	N.A.	31 (81)	N.A.	49 (80)	N.A.
Ouachita & Black R.																
Jonesville	1 (83)	N.A.	7 (80)	N.A.	6 (81)	N.A.	8 (80)	N.A.	1 (83)	N.A.	2 (80)	N.A.	8 (81)	N.A.	9 (81)	N.A.
Columbia	1 (81)	N.A.	0	N.A.	1 (81)	N.A.	2 (81)	N.A.	1 (81)	N.A.	0	N.A.	2 (81)	N.A.	3 (81)	N.A.
Felsenthal	0	N.A.	0	N.A.	0	N.A.	0	N.A.	1 (84)	N.A.	0	N.A.	0	N.A.	1 (84)	N.A.
Thatcher	0	N.A.	0	N.A.	0	N.A.	0	N.A.	1 (85)	N.A.	0	N.A.	0	N.A.	1 (85)	N.A.

TABLE A-3-2 (CONTINUED)
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Red River																
L&D 1	14 (85)	N.A.	0	N.A.	0	N.A.	14 (85)	N.A.	7 (85)	N.A.	0	N.A.	0	N.A.	7 (85)	N.A.
Overton (u. const.)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.
L&D 3 (u. const.)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.
Atchafalaya (Old) R.																
Old River	103 (87)	103	1 (85)	0	76 (87)	76	179 (87)	179	35 (87)	35	1 (85)	0	18 (87)	18	53 (87)	53

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.
** Zero indicates that no data is available.
*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:
Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.
Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood
Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-3-3A
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	32984	40687	38942	41756	43369	51182	55300	62183	59565	55967	49218	43299
Other Agricultural Prdcts	5547	7946	7694	9677	10786	12965	11167	12168	13989	11807	11109	13466
Metallic Ores	2224	2438	2507	2722	2398	1404	1282	975	1466	1666	2029	2064
Coal	11436	11189	11930	10088	11710	17147	27386	19323	19400	24987	28653	32503
Crude Petroleum	4346	4773	3688	5750	4977	5191	3855	3132	3487	3193	1684	862
Non-Metlc Minerals & Prod	7412	7336	8487	11218	11438	9713	7834	7648	9122	11961	11913	11631
Lumber, Wood Prod. & Pulp	840	999	896	825	828	745	609	814	719	741	597	578
Industrial Chemicals	9167	9875	10375	10967	11966	11485	10897	9427	9909	12033	11270	12166
Agricultural Chemicals	4613	4640	5530	5705	5564	5899	5067	4314	6086	7249	6798	8258
Petroleum Prdcts	20346	21982	24330	25057	22664	20563	17797	15676	15169	15455	14759	18018
Metallic Products & Scrap	4238	4421	4516	5404	5674	5403	4387	3570	3849	5077	5573	6725
All Other Commodities	5494	5420	4916	5791	5503	4462	3636	3826	5373	6434	6266	6621
TOTAL	108647	121706	123811	134960	136877	146159	149217	143056	148134	156570	149869	156191

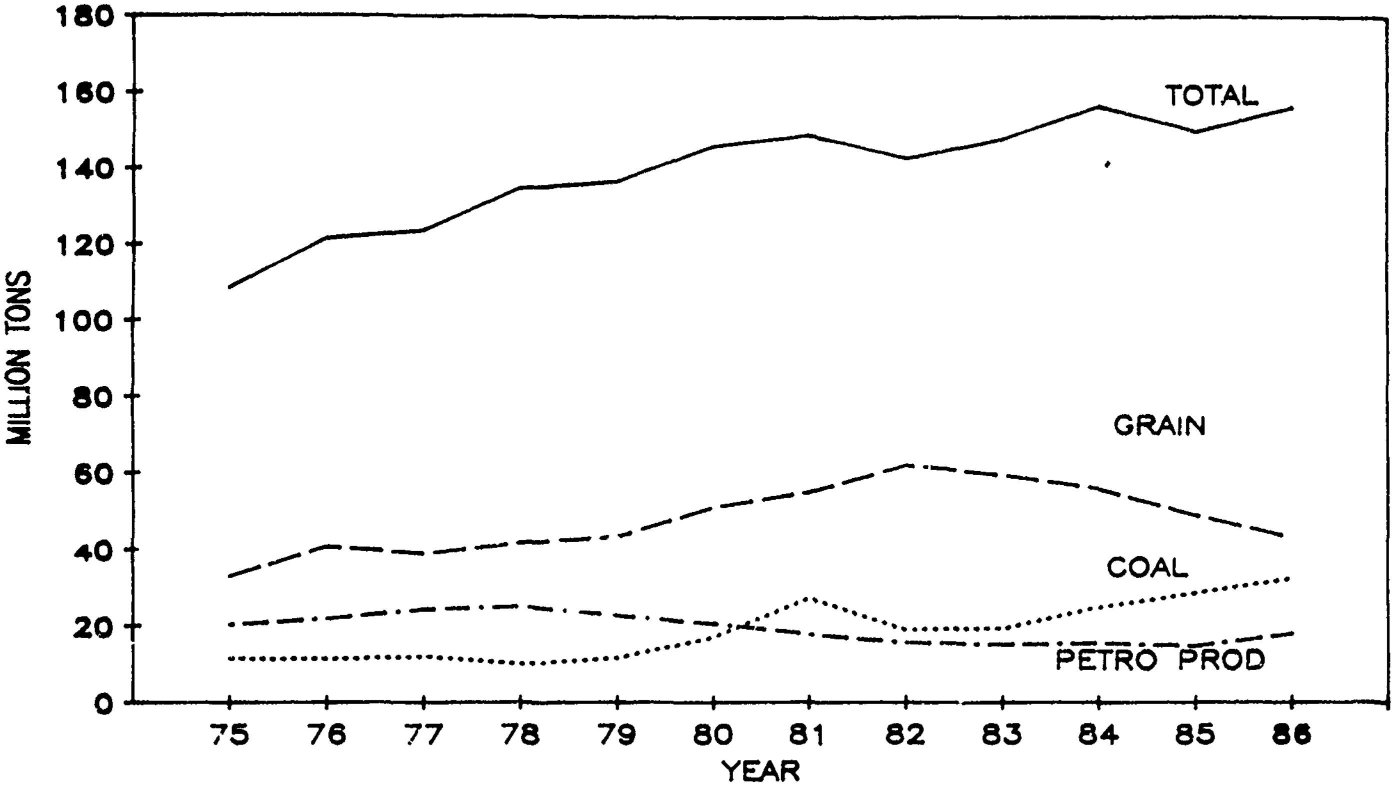
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

TABLE A-3-3B
SEGMENT NUMBER 3
ARKANSAS RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	686	891	1040	996	1065	1484	1664	1874	1908	1788	1603	1585
Other Agricultural Prdcts	61	138	177	178	150	318	170	339	243	243	197	187
Metallic Ores	374	391	755	375	166	213	51	91	40	36	51	50
Coal	147	235	515	1485	801	719	1023	923	950	1265	718	648
Crude Petroleum	0	31	21	0	0	17	11	0	0	0	12	0
Non-Metlc Minerals & Prod	2292	2289	2765	2962	2893	2237	1692	1617	1837	2330	2427	2687
Lumber, Wood Prod. & Pulp	167	185	131	171	138	165	170	240	162	156	88	70
Industrial Chemicals	157	186	256	412	565	356	239	301	324	433	344	457
Agricultural Chemicals	293	234	353	334	440	629	392	376	514	636	873	1134
Petroleum Prdcts	448	1266	2072	1983	1655	1772	1657	1475	1085	951	706	845
Metallic Products & Scrap	206	282	377	487	423	508	544	425	464	656	616	592
All Other Commodities	326	410	684	469	115	43	61	152	41	27	90	90
TOTAL	5157	6538	9146	9852	8411	8461	7674	7823	7568	8521	7725	8396

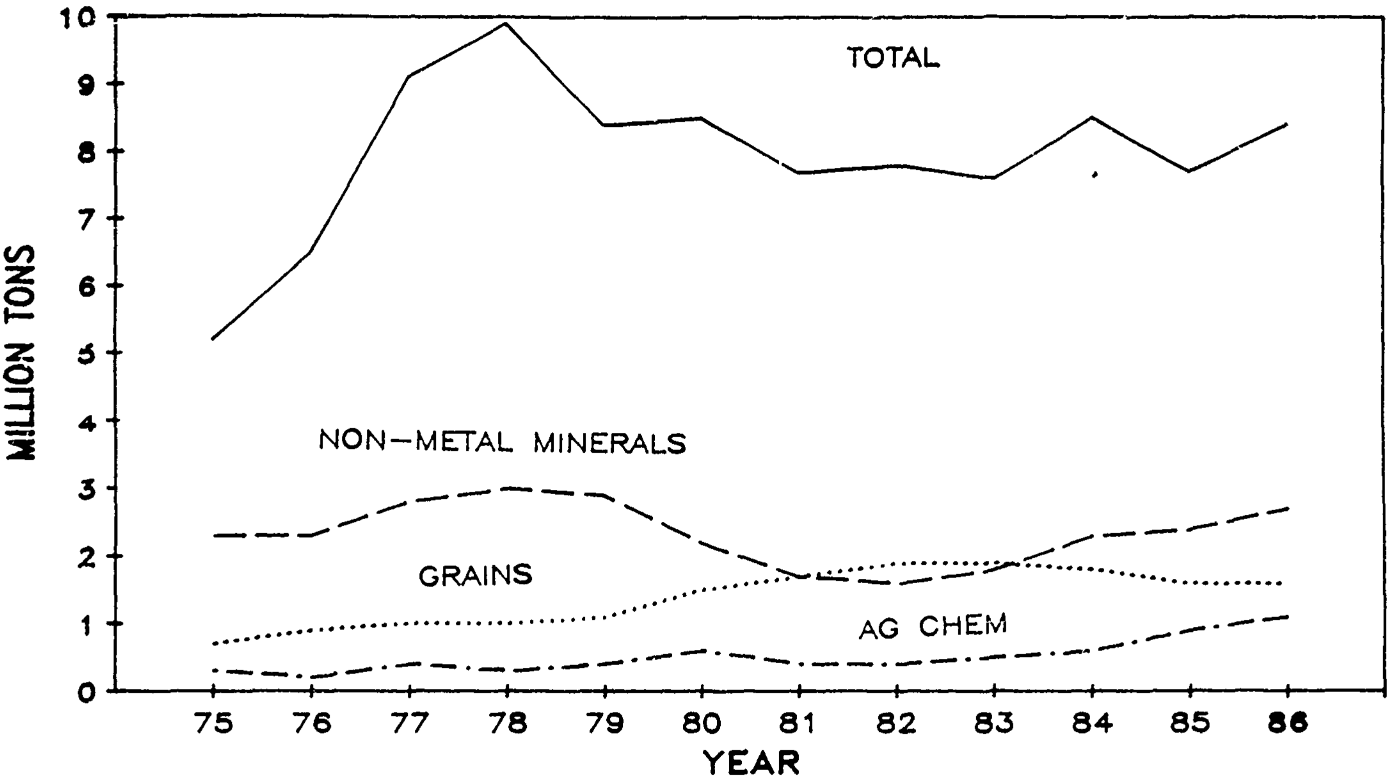
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-3-2A
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-3-2B
SEGMENT NUMBER 3
ARKANSAS RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986

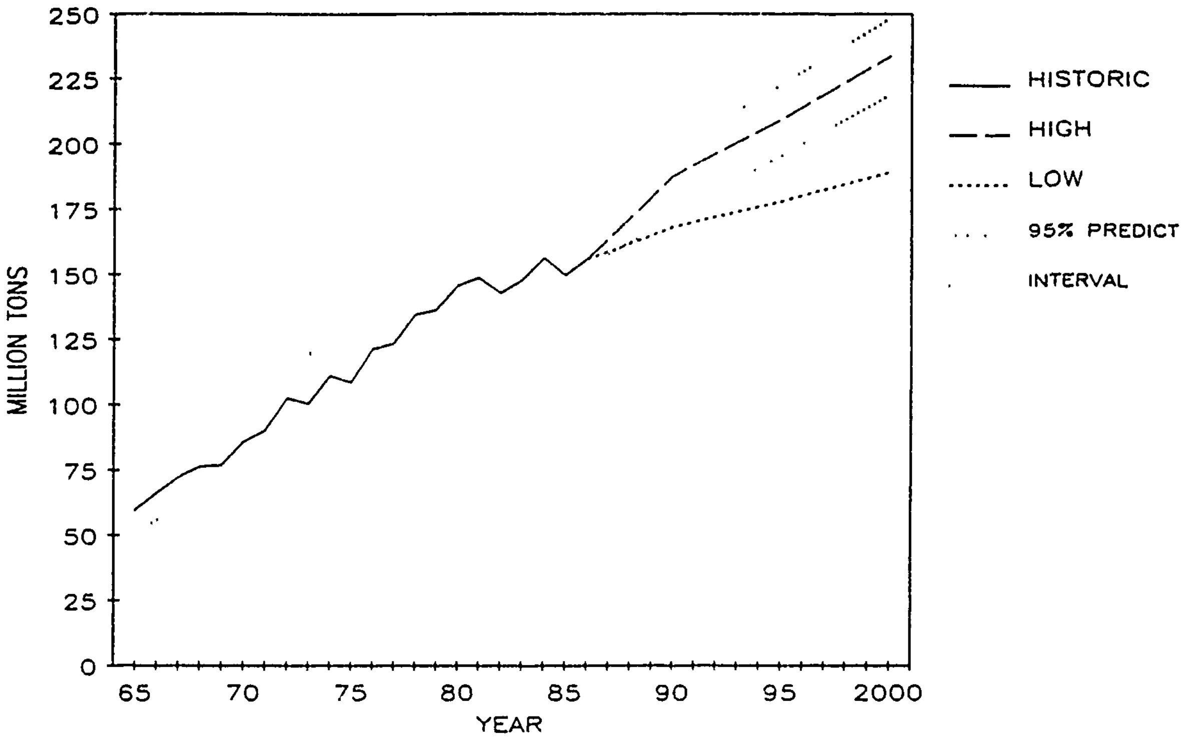


DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-3-3A
SEGMENT NUMBER 3

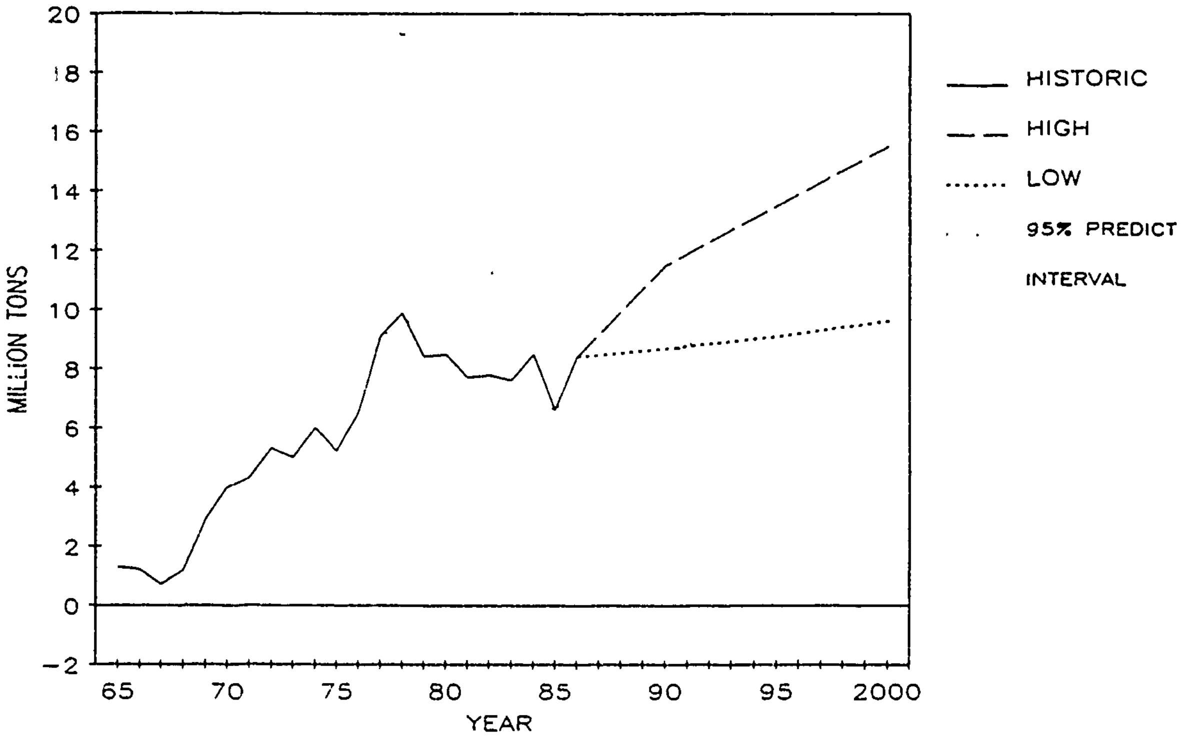
LOWER MISSISSIPPI RIVER TRAFFIC

HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

FIGURE A-3-3B
SEGMENT NUMBER 3
ARKANSAS RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-3-4
SEGMENT NUMBER 3
LOWER MISSISSIPPI

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions) 1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
Norrel	5.0	N.A.	5.3	5.7	N.A.	N.A.	N.A.	1.3	1.3	N.A.	N.A.	N.A.	4.2	4.3	N.A.	4	4	N.A.
L&D 2	5.0	N.A.	5.3	5.8	N.A.	N.A.	N.A.	1.3	1.3	N.A.	N.A.	N.A.	4.2	4.3	N.A.	4	4	N.A.
L&D 3	5.0	N.A.	5.0	5.5	N.A.	N.A.	N.A.	1.1	1.2	N.A.	N.A.	N.A.	4.5	4.5	N.A.	4	4	N.A.
L&D 4	4.1	N.A.	4.8	5.4	N.A.	N.A.	N.A.	1.1	1.2	N.A.	N.A.	N.A.	4.5	4.6	N.A.	5	5	N.A.
L&D 5	4.1	N.A.	4.4	4.7	N.A.	N.A.	N.A.	0.9	1.0	N.A.	N.A.	N.A.	4.7	4.5	N.A.	4	4	N.A.
David T. Terry	4.1	N.A.	4.4	4.7	N.A.	N.A.	N.A.	0.9	1.1	N.A.	N.A.	N.A.	4.6	4.4	N.A.	4	4	N.A.
Murray	2.8	N.A.	3.7	3.6	N.A.	N.A.	N.A.	0.8	0.7	N.A.	N.A.	N.A.	4.9	4.9	N.A.	4	4	N.A.
Toad Suck	2.6	N.A.	3.7	3.6	N.A.	N.A.	N.A.	0.7	0.7	N.A.	N.A.	N.A.	5.0	4.8	N.A.	4	4	N.A.
Ormond	2.6	N.A.	3.6	3.5	N.A.	N.A.	N.A.	0.7	0.7	N.A.	N.A.	N.A.	5.1	5.1	N.A.	4	4	N.A.
Dardanelle	2.6	N.A.	3.7	3.5	N.A.	N.A.	N.A.	0.8	0.7	N.A.	N.A.	N.A.	4.7	5.0	N.A.	4	4	N.A.
Ozark	2.5	N.A.	3.6	3.4	N.A.	N.A.	N.A.	0.7	0.7	N.A.	N.A.	N.A.	5.2	5.1	N.A.	4	4	N.A.
James W. Trimble	2.5	N.A.	3.8	3.9	N.A.	N.A.	N.A.	1.3	1.5	N.A.	N.A.	N.A.	2.9	2.5	N.A.	3	3	N.A.
W. D. Mayo	2.2	N.A.	3.3	2.9	N.A.	N.A.	N.A.	0.7	0.6	N.A.	N.A.	N.A.	4.8	4.8	N.A.	4	4	N.A.
Robert S. Kerr	2.2	N.A.	3.3	2.9	N.A.	N.A.	N.A.	0.7	0.6	N.A.	N.A.	N.A.	4.7	4.8	N.A.	4	4	N.A.
Webbers Falls	2.1	N.A.	2.8	2.5	N.A.	N.A.	N.A.	0.6	0.6	N.A.	N.A.	N.A.	4.6	4.5	N.A.	4	4	N.A.
Chouteau	1.3	N.A.	2.4	2.5	N.A.	N.A.	N.A.	0.6	0.6	N.A.	N.A.	N.A.	4.0	4.4	N.A.	3	4	N.A.
Newt Graham	1.2	N.A.	2.3	2.4	N.A.	N.A.	N.A.	0.6	0.6	N.A.	N.A.	N.A.	3.9	4.2	N.A.	3	4	N.A.
Jonesville	0.8	2.3%	0.6	0.1	1.0	0.6	0.4	0.2	0.1	0.5	0.2	0.3	2.7	2.3	2.3	3	2	3
Columbia	0.5	0.0%	0.2	0.1	0.5	0.3	0.2	0.1	0.0	0.2	0.1	0.1	2.2	2.6	2.3	2	3	3
Felsenthal	N.A.	N.A.	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.7	0.1	0.9	1	1	2
Thatcher	N.A.	N.A.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.5	1	1	1
L&D 1	N.A.	N.A.	1.4	0.3	1.9	1.8	0.1	0.8	0.2	0.9	0.5	0.4	1.7	1.7	2.2	2	2	3
Overton	N.A.	N.A.	N.A.	N.A.	0.1	0.1	0.0	N.A.	N.A.	0.0	0.0	0.0	N.A.	N.A.	1.7	N.A.	N.A.	2
L&D 3	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Old River	5.1	4.6%	4.9	4.9	8.0	4.0	4.0	1.9	1.8	2.5	1.4	1.1	2.6	2.7	3.1	3	3	3

N.A. = NOT AVAILABLE

SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers 1986.

TABLE A-3 5
SEGMENT NUMBER 3
LOWER MISSISSIPPI

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
LWR MISS R										
Oh R-Bn Rg	26,252	29,013	32,735	30,025	32,037	34,280	46,839	42,030	44,032	41,272
Ark System	14,619	13,464	14,184	13,674	19,657	15,296	16,963	19,975	21,809	19,212
White R	534	538	882	674	1,259	1,872	945	1,263	2,058	1,917
Ouach/Blk	2,139	2,949	3,467	2,507	2,580	2,550	3,326	4,204	4,084	2,784
Red R	1,103	588	63	211	959	1,575	510	170	1,538	1,864
Atchaf R	5,712	1,792	2,590	3,565	4,844	6,221	13,412	22,002	19,636	17,118
Subtotal	50,359	48,344	53,921	50,656	61,336	61,794	81,995	89,644	93,157	84,167

TON MILES OF TRAFFIC (000) CY 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
LWR MISS R										
Oh R-Bn Rg	73,322,750	78,985,289	81,258,413	88,308,199	92,114,332	87,391,058	90,451,054	95,825,890	92,863,242	97,864,830
Ark System	1,297,557	1,694,930	1,472,861	1,819,076	1,861,629	1,798,719	1,731,825	1,911,764	1,485,206	1,545,066
White R	75,884	71,620	82,035	84,916	36,968	81,405	69,539	83,384	82,925	70,394
Ouach/Blk	135,976	126,444	148,559	97,407	79,872	49,571	51,855	49,073	49,239	78,403
Red R	45,043	63,412	86,696	92,007	51,551	33,455	40,924	122,837	196,805	182,077
Atchaf R	491,927	458,974	258,917	232,215	270,089	224,356	318,309	223,913	280,064	317,568
Subtotal	75,369,137	81,400,669	83,307,481	90,633,820	94,414,441	89,578,564	92,663,506	98,216,861	94,957,481	100,058,338

TABLE A-3-5 (CONTINUED)
SEGMENT NUMBER 3
LOWER MISSISSIPPI

O & M COSTS PER TON MILE ($) 1977-1986

LWR MISS R										
Oh R-Bn Rg	0.0004	0.0004	0.0004	0.0003	0.0003	0.0004	0.0005	0.0004	0.0005	0.0004
Ark System	0.0113	0.0079	0.0096	0.0075	0.0106	0.0085	0.0098	0.0104	0.0147	0.0124
White R	0.0070	0.0075	0.0108	0.0079	0.0341	0.0230	0.0136	0.0151	0.0248	0.0272
Ouach/Blk	0.0157	0.0233	0.0233	0.0257	0.0323	0.0514	0.0641	0.0857	0.0829	0.0355
Red R	0.0245	0.0093	0.0007	0.0023	0.0186	0.0471	0.0125	0.0014	0.0078	0.0102
Atchaf R	0.0116	0.0039	0.0100	0.0154	0.0179	0.0277	0.0421	0.0983	0.0701	0.0539
Segment	0.0007	0.0006	0.0006	0.0006	0.0006	0.0007	0.0009	0.0009	0.0010	0.0008

NOTE: FY 1987 costs in order by the waterway(s) above are 44,782, 26,990, 2,183, 4,325, 1,118, and 7,653, respectively and the subtotal is 87,05 . 1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

In Segment 3 Mississippi River and Tributaries projects costs are used for the Mississippi River, Ohio River to Baton Rouge, except for MR & T costs for the Old River, which are used for the Atchafalya River. MR&T costs include both maintenance and construction is long term and similar to maintenance work of the joint use costs among navigation, flood control, and other purposes 33% are designated as navigation costs.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-3-6
SEGMENT NUMBER 3
LOWER MISSISSIPPI

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
MISSISSIPPI RIVER AND TRIBUTARIES								
Miss R. Channel Improve.	CCF	1928	2010	3,076,294 (3)	0	1, 666,353 (3)	54	94,900 (3)
ARKANSAS RIVER								
All locks	CCF	1963	1967-70 (1)	547,500	0	542,200	99	4,350
Entrance L&D	SCF	Unk	1990	Unk	0	Unk	Unk	Unk
	CINA	Unk	Unk	Unk	0	0	0	0
SC&SE Oklahoma	SCF	1984	1988	2,075	0	2,075	100	0
Basin Mult. Purpose	SCF	Unk	1989	2,050	0	1,490	73	430
Great Bend to Tulsa	SCF	Unk	1991	7,340	0	6,209	85	400
WHITE RIVER								
To Batesville	SANS	Unk	Unk	2,200	0	0	0	0
	CANS	Unk	Unk	32,000	0 (4)	0	0	0
OUACHITA-BLACK RIVERS								
Felsenthal	CCF	1964	1984 (1)	274,702 (2)	0	227,046 (2)	83 (2)	2,000 (2)
H. K. Thatcher	CCF	1964	1984 (1)	- (2)	0	- (2)	- (2)	- (2)
Basin Multiple Purpose	SCF	1976	1988	8,555	0	8,555	100	0
RED RIVER								
Mississippi River to Shreveport								
L&D 1	CCF	1973	1984 (1)	1,731,915 (2)	0	883,053 (2)	50 (2)	118,000 (2)
Overton	CCF	1973	1987	- (2)	0	- (2)	- (2)	- (2)

TABLE A-3-6 (continued)
SEGMENT NUMBER 3
LOWER MISSISSIPPI
STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
L&D 3	CCF	1973	1992	- (2)	0	- (2)	- (2)	- (2)
L&D 4	CAS	Unk	Unk	- (2)	0	- (2)	- (2)	- (2)
L&D 5	CAS	Unk	Unk	- (2)	0	- (2)	- (2)	- (2)
Shreveport-Daingerfield, TX (Non Fuel Taxed Waterway)								
L&D 6	CCNF	1973	Unk	656,635 (2)	0	12,870 (2)	2 (2)	0 (2)
L&D 7	CCNF	1973	Unk	- (2)	0	- (2)	- (2)	- (2)
L&D 8	CCNF	1973	Unk	- (2)	0	- (2)	- (2)	- (2)
Basin Multiple Purpose	SCF	Unk	1988	3,100	0	2,480	79	660
Basin Mult. Purp., AR, LA	SAS	1988	1989	450	0	0	0	450
Basin Mult. Purp., OK, TX	SCF	Unk	1990	1,930	0	1,576	82	104
ATCHAFALAYA RIVER								
Atchafalaya Basin (MR&T)	CCF	1928	2010	1,468,000 (3)	0	591,723 (3)	41	31,000 (3)
YAZOO RIVER (NON FUEL TAXED WATERWAY)								
Yazoo	SCNF	1977	Unk	Unk	0	Unk	Unk	0
To Greenwood	CCNF	Unk	Unk	237,000	0	0	0	0

(1) Year operational.
(2) Total amounts for the waterway.
(3) Cost are for multiple purpose flood control project, of which navigation is one purpose.
(4) Project was authorized under Section 601 of PL 99-662 rather than Section 301 and is thus <u>not</u> cost shared in accordance with inland waterways cost sharing.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-3-7
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Norrel	1967	25	31	5	5.3	5.7	N.A.	6.0	14.0	N.A.	N.A.	N.A.	N.A.
L&D 2	1967	25	31	5	5.3	5.8	N.A.	6.0	16.0	N.A.	N.A.	N.A.	N.A.
L&D 3	1968	26	32	5	5	5.5	N.A.	0.0	10.0	N.A.	N.A.	N.A.	N.A.
L&D 4	1968	26	33	4.1	4.8	5.4	N.A.	17.0	32.0	N.A.	N.A.	N.A.	N.A.
L&D 5	1968	25	31	4.1	4.4	4.7	N.A.	7.0	14.6	N.A.	N.A.	N.A.	N.A.
David Terry	1968	25	31	4.1	4.4	4.7	N.A.	6.0	14.6	N.A.	N.A.	N.A.	N.A.
Murray	1969	29	31	2.8	3.7	3.6	N.A.	34.0	28.6	N.A.	N.A.	N.A.	N.A.
Toad Suck	1969	27	31	2.6	3.7	3.6	N.A.	44.0	38.5	N.A.	N.A.	N.A.	N.A.
Ormond	1969	28	31	2.6	3.6	3.5	N.A.	42.0	34.6	N.A.	N.A.	N.A.	N.A.
Dardanelle	1969	28	31	2.6	3.7	3.5	N.A.	41.0	34.6	N.A.	N.A.	N.A.	N.A.
Ozark	1969	28	31	2.5	3.6	3.4	N.A.	41.0	36.0	N.A.	N.A.	N.A.	N.A.
James W. Trimble	1969	28	31	2.5	3.8	3.9	N.A.	51.0	56.0	N.A.	N.A.	N.A.	N.A.
W.D. Mayo	1970	27	29	2.2	3.3	2.9	N.A.	47.0	31.8	N.A.	N.A.	N.A.	N.A.
Robert S Kerr	1970	27	29	2.2	3.3	2.9	N.A.	45.0	31.8	N.A.	N.A.	N.A.	N.A.
Webbers Falls	1970	25	27	2.1	2.8	2.5	N.A.	36.0	19.0	N.A.	N.A.	N.A.	N.A.
Chouteau	1970	24	26	1.3	2.4	2.5	N.A.	89.0	92.3	N.A.	N.A.	N.A.	N.A.
Newt Graham	1970	24	26	1.2	2.3	2.4	N.A.	88.0	100.0	N.A.	N.A.	N.A.	N.A.
Jonesville	1972		26	0.8	0.6	0.1	1.0	-30.0	-87.5	25.0	N.A.	3.8%	N.A.
Columbia	1972		26	0.5	0.2	0.1	0.5	-65.0	-80.0	0.0	N.A.	1.9%	N.A.
Felsenthal	1983		26	N.A.	0.1	0.0	0.0	N.A.	-100.0	N.A.	N.A.	0.0%	N.A.
Thatcher	1983		26	N.A.	0.0	0.0	0.0	N.A.	N.A.	N.A.	N.A.	0.0%	N.A.
L&D 1	1985	21	22	N.A.	1.4	0.0	1.9	N.A.	-100.0	N.A.	9.0%	8.6%	N.A.

TABLE A-3-7 (continued)
SEGMENT NUMBER 3
LOWER MISSISSIPPI RIVER

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Overton	1987	N.A.	N.A.	N.A.	N.A.	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3	N.A.	N.A.	N.A.	N.A.	N.A.	4.0	N.A.	N.A.	33.3	N.A.	N.A.	N.A.	N.A.
Old river	1963	59	62	5.1	4.9	4.9	8.0	-3.9	-3.9	56.9	13.6%	12.9%	28

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 4
ILLINOIS WATERWAY

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-4-1). The Illinois Waterway includes four sections. The lower section is 300 feet wide and extends from the waterway's mouth at the Mississippi near Grafton (38 miles above St. Louis) to Lockport, with 273 miles on the Illinois River and 18.1 miles on the DesPlaines River. The center section on the Chicago Sanitary and Ship Canal is 160 feet wide and extends 12.4 miles from the Lockport to the junction with the Calumet-Sag Channel. From the junction the third section follows the Chicago Sanitary and Ship Canal and South Branch of the Chicago River to Lake Street and the Chicago River for 22.1 miles with channels 160-300 feet wide. The fourth section, from the junction to O'Brien Lock and Lake Calumet via the Calumet-Sag channel and Little Calumet and Calumet Rivers, is 23.8 miles long and 225 feet wide. All four sections total 349 miles with project depths of nine feet deep. The remaining distances to Lake Michigan are via the deep draft Chicago River and Chicago Harbor from Lake Street and Lake Calumet and Calumet Harbor and River from O'Brien Lock. Navigation is year-round, but ice causes problems in severe winters.

b. Locks (Table A-4-1). The eight locks on the waterway are 600 feet long and 100 feet wide, except for O'Brien Lock, which is 1,000 feet long. They provide a total lift of about 200 feet with the individual lift at locks ranging from 5 feet at O'Brien Lock to 40 feet at Lockport Lock. At the two downstream sites, Peoria and LaGrange, the moveable dams are lowered during high water (about 24 weeks of the year) and navigation passes over the dams without needing to use the locks. Five locks are 55 years old and two are 49 years old, but O'Brien Lock is only 28 years old. Major rehabilitation has been completed at five of the seven old locks and is underway at the other two. In addition, Chicago Lock, located at the mouth of Chicago River in Chicago Harbor, is 600 feet long and 80 feet wide and 50 years old.

2. PERFORMANCE CHARACTERISTICS (Table A-4-2).

The total average processing time for 1987 ranged from 38 minutes to 371 minutes (6.18 hours), and the median value of 139 minutes. Total peak average processing time for the 1980-1987 time period ranged from 49 minutes (1980) for T.J. O'Brien to 977 minutes or 16.28 hours (1981) for Peoria. In this segment, the highest total peak average processing time from 1980 to 1987 was for Peoria lock in 1981 (16.28 hours). Total delay ranged from 173 hours to 15,384 hours in 1987. Total delay time is high at all the locks except for T. J. O'Brien. The median value of total delay is 3,388.50 hours, and T.J. O'Brien was the only lock that fell considerably below this value. The peak total delay for the 1980-1987 time period varied from 1152 hours (1980) for T. J. O'Brien to 35,925 hours (1981) for Peoria. Peoria had the highest peak total delay (35,925 hours in 1981) in this segment from 1980 to 1987. Lock utilization for 1987 ranged from 34% to 54%. Utilization rates for LaGrange, Peoria, Marseilles and Lockport were all greater than the median value of 48.5%. The peak utilization data from 1980 through 1987 ranged from 38% (1986) at T.J. O'Brien to 100% (1981) at LaGrange. In this segment, the highest peak utilization for the 1980-1987 time period was 100% in 1981 for

LaGrange. Total downtime ranged from 6 hours to 336 hours. Three locks (Starved Rock, Marseilles, Dresden Island and T.J. O'Brien) fell below the median of 105.5 hours. The total peak downtime varied from 15 hours in 1982 at T.J. O'Brien to 1631 hours in 1985 at LaGrange. The highest total peak downtime during the 1980-1987 time period occurred in 1985 at LaGrange (1631 hours). Total stall events for 1987 ranged from 6 to 119, and the median value is 46 stall events. The peak for total stall events from 1980 to 1987 ranged from 13 at T.J. O'Brien in 1982 to 119 at LaGrange in 1987. From 1980 through 1987, LaGrange had the highest peak total stall events of 119 in 1987.

3. COMMODITY TRAFFIC (Tables A-2, A-4-3,-4); (Figures A-4-2,-3).

a. Historical. Waterborne commerce on the Illinois Waterway, which links Lake Michigan with the Mississippi, increased steadily until the mid 1970s and has been variable since then. Tonnage declined from 45.8 million in 1975 to 42.3 million in 1986, but increases occurred in 1980 (44.1 million) and 1983 (43 million) according to the Waterborne Commerce Statistics Center. The 1986 traffic on the waterway increased by about 10 percent over 1985. Principal commodities include grains and oilseeds, petroleum products, and coal, but non-metallic minerals and metallic products and scrap are also important. Grain and oilseed tonnage grew from a 1979 low of 12.5 million to a peak in 1982 of 18.6 million (45 percent of total traffic in that year), then declined to 13.8 million in 1986. Petroleum products tonnage has declined gradually from 7.5 million in 1975 to 5.5 million in 1985, before recovering to 6.1 million in 1986. Coal traffic peaked in 1975 at 7.7 million tons, declined to 4.2 million by 1978, then increased to 5.8 million in 1980. Coal movements in 1986 exceeded 7.5 million tons, nearly equalling the 1975 high and jumping 2.5 million tons from 1985.

b. Forecast. Waterborne commerce on the Illinois Waterway is projected to increase from 42.3 million tons to between 49.2 and 60.1 million tons by 2000. This represents a turnaround from the average annual decline of 1.8 percent experienced between 1975-85. Farm products and coal greatly influence future traffic forecasts. Future grain exports are expected to generate increasing farm products traffic.

c. Tonnage at Locks. Based on average annual percent change, all individual locks showed a decrease in 1987 levels from 1977 levels in tonnage ranging from -0.2% (LaGrange) to -2.4% (T.J. O'Brien). For 1977-87 period, the decrease in actual tonnage ranged from 0.2 million tons (LaGrange), to 1.9 million tons (T.J. O'Brien). Total tonnage by lock for 1987 ranged from 6.8 million tons at T.J. O'Brien to 30.3 million tons at LaGrange.

4. OPERATIONS AND MAINTENANCE COSTS (Table A-4-5).

The O&M cost in actual dollars increased from about $9 million in 1977 to about $13 million in 1986. That is about a 13% decline in real terms when adjusted for about 68% inflation during the period of 1977 to 1986. In 1984, however, the O&M cost was about 14 million dollars, higher than that for 1985 and 1986. Traffic remained relatively constant at about 8 billion ton-miles during the period of 1977 to 1986. The O&M cost per ton-mile ranged from 1.1 mills in 1977 to 1.5 mills in 1986. This segment ranked the fourth lowest in unit cost of all nine segments.

5. PROGRAM STATUS (Table A-4-6).

Like the Upper Mississippi River, improvements on the Illinois Waterway's 49 to 55 year old locks and dams are being accomplished through major rehabilitation rather than construction of replacement locks. Rehabilitation of the Starved Rock and Dresden Island Locks and Dams was completed in 1983 and 1985 at costs of $16.7 and $13.3 million respectively. Rehabilitation of the other five old facilities started in 1983 through 1986 and is being completed in 1987 through 1990 at individual costs ranging from $15.0 million at Marseilles Lock and Dam to $23.8 million at Brandon Road Lock and Dam. The five year rehabilitation of Lockport Lock and Dam for $22.7 million was completed in 1987. Downriver at Brandon Road Lock and Dam the work being completed in 1988 has included resurfacing the locks and rehabilitating its gates, replacing the lock's electrical system and miter gate machinery, and rehabilitating the dam gates and channel wall. Also being completed in 1988 is the work further downriver at Marseilles that has involved resurfacing the dam and guidewall, replacing dam tainter gates and gate machinery, rehabilitating the dam walkway bridge, and installing a surveillance system and remote operating equipment. At the downriver LaGrange and Peoria Locks and Dams the work includes wicket dam and lock rehabilitation and replacement of the dam tainter gates and dam machinery, plus maintenance of dam bulkheads at the Peoria site. The work is 43 and 36 percent complete respectively at LaGrange ($20.3 million) and Peoria ($21.3 million) Locks and Dams, and will be 92 and 97% complete with funds requested for FY 1989.

6. LOCK CAPACITY CHARACTERISTICS (Table A-4-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-4-4.

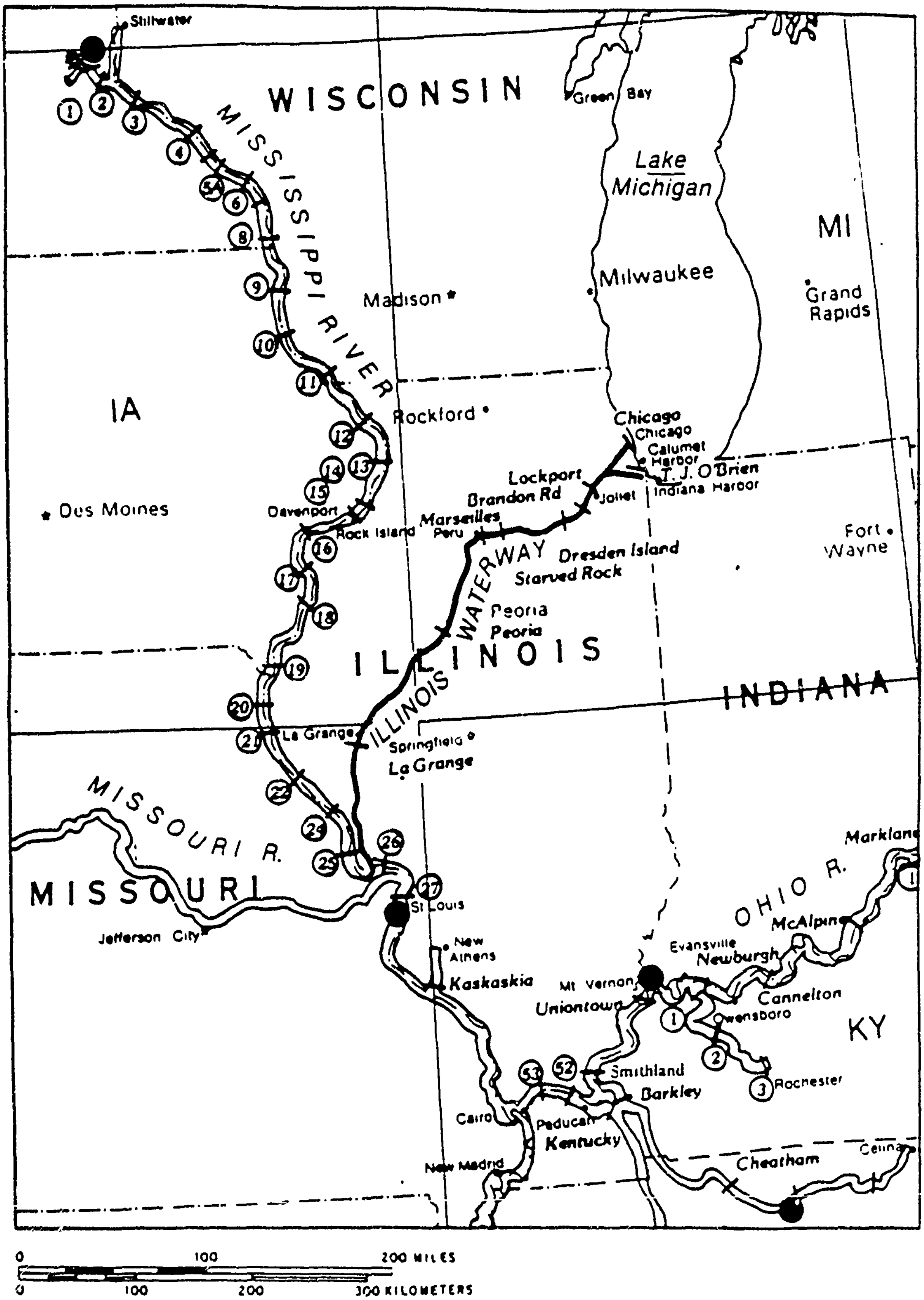


Figure A-4-1
Segment 4, Illinois Waterway

TABLE A-4-1
SEGMENT NUMBER 4
ILLINOIS WATERWAY

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
LaGrange L&D	80.2	1939	49	110	600	10
Peoria L&D	157.7	1939	49	110	600	11
Starved Rock L&D	231.0	1933	55	110	600	19
Marseilles L&D	244.6	1933	55	110	600	24
Dresden Island L&D	271.5	1933	55	110	600	22
Brandon Road L&D	286.0	1933	55	110	600	34
Lockport Lock	291.1	1933	55	110	600	40
T.J. O'Brien Lock	326.5	1960	28	110	1000	5

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986

TABLE A-4-2
SEGMENT NUMBER 4
ILLINOIS WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)		TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
LaGrange	750 (81)	295	93 (81)	76	843 (81)	371	26053 (81)	15384	100 (81)	54
Peoria	893 (81)	125	84 (86)	63	977 (81)	188	35925 (81)	6947	76 (81)	49
Starved Rck	129 (82)	44	71 (85)	67	192 (82)	111	9124 (82)	2116	57 (83)	45
Marseilles	162 (82)	75	88 (86)	82	238 (82)	157	11245 (81)	3527	65 (82)	52
Dresden Islnd	80 (83)	44	68 (87)	68	147 (83)	112	5680 (81)	2170	53 (86)	46
Brandon Road	185 (84)	56	68 (86)	65	257 (84)	121	10264 (84)	3250	63 (81)	48
Lockport	127 (87)	127	77 (85)	71	198 (87)	198	8577 (81)	7259	65 (86)	52
T.J. O'Brien	24 (81)	4	34 (87)	34	49 (80)	38	1152 (81)	173	38 (86)	34

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year

Note: Lockage times for LaGrange and Peoria Locks are preliminary and to be revised.

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-4-2
SEGMENT NUMBER 4
ILLINOIS WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL STALL EVENTS***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
LaGrange	103 (85)	9	51 (82)	36	1500 (85)	185	1631 (85)	230	11 (83)	3	29 (81)	12	104 (87)	104	119 (87)	119
Peoria	81 (84)	78	42 (81)	21	856 (87)	56	155 (87)	155	52 (87)	52	34 (81)	12	44 (87)	44	108 (87)	108
Straved Rck	182 (86)	1	1460 (81)	12	21 (84)	18	1481 (81)	31	43 (83)	2	87 (86)	16	80 (83)	40	74 (83)	58
Marseilles	57 (87)	57	92 (82)	13	106 (84)	18	169 (84,	88	36 (86)	27	167 (82)	20	202 (84)	109	156 (87)	156
Dresden Islnd	78 (83)	6	19 (87)	19	15 (85)	14	97 (83)	39	38 (83)	6	8 (85)	3	52 (83)	26	51 (83)	35
Brandon Road	49 (85)	10	99 (87)	99	809 (84)	14	852 (84)	123	30 (81)	7	10 (83)	5	175 (86)	102	114 (87)	114
Lockport	840 (81)	24	32 (85)	0**	694 (84)	312	856 (81)	336	49 (81)	15	5 (85)	1	854 (87)	854	860 (87)	860
T.J. O'Brien	5 (82)	4	7 (82)	1	4 (83)	1	15 (82)	6	5 (81)	4	3 (82)	1	6 (82)	1	13 (82)	6

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.

** Zero indicates that no data is available.

*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

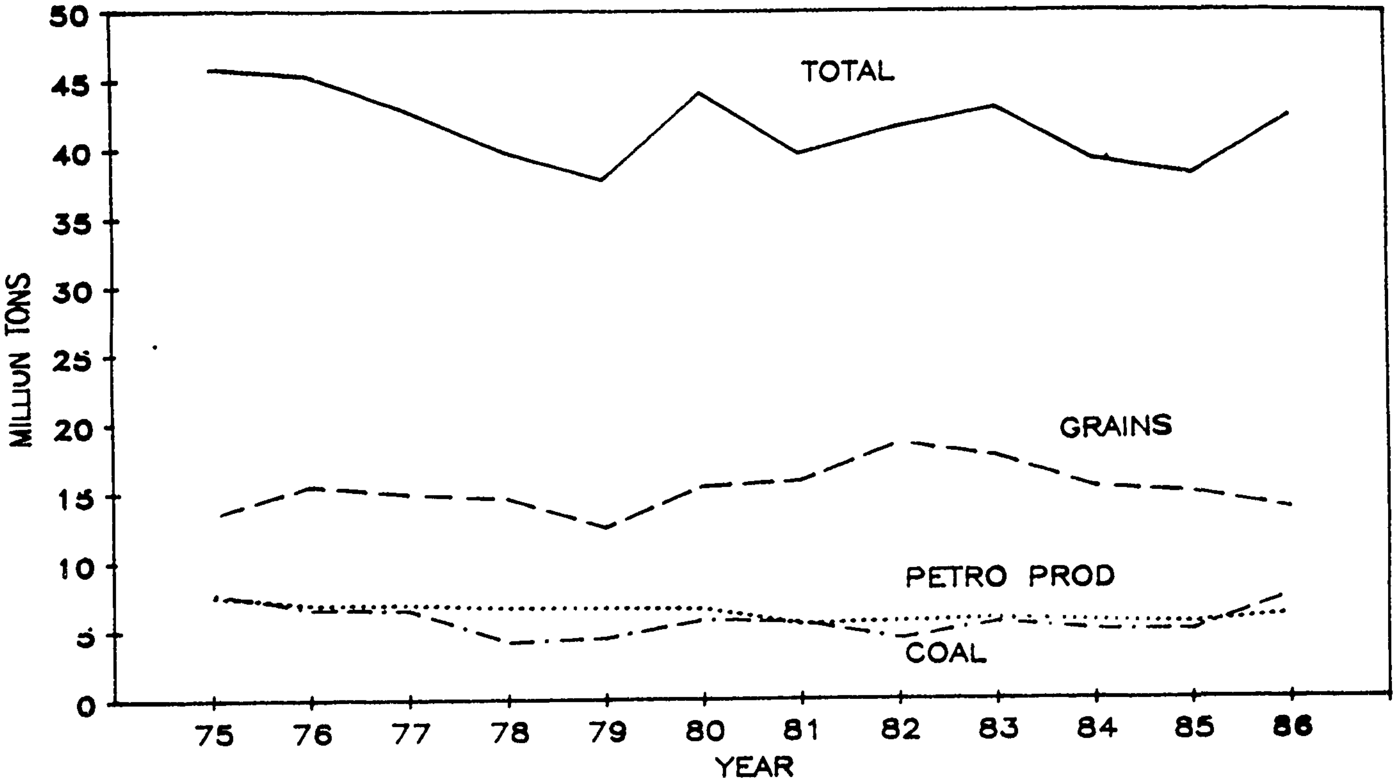
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-4-3
SEGMENT NUMBER 4
ILLINOIS WATERWAY TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	13392	15505	14919	14625	12518	15520	15937	18634	17564	15382	15022	13781
Other Agricultural Prdcts	785	1066	1013	1110	1504	1892	1525	1505	2099	1708	1320	2023
Metallic Ores	221	112	147	282	117	153	91	110	520	114	245	96
Coal	7670	6590	6521	4246	4469	5805	5595	4434	5568	5046	4997	7545
Crude Petroleum	42	186	150	71	115	37	43	361	1048	405	68	140
Non-Metlc Minerals & Prod	5590	5652	5441	4787	5196	5145	2910	4917	4381	4301	4085	4261
Lumber, Wood Prod. & Pulp	127	143	127	75	92	91	63	73	82	64	58	46
Industrial Chemicals	2827	2757	2662	2692	2587	2658	2386	2155	2176	2651	2857	3489
Agricultural Chemicals	1490	1722	1672	1725	1491	1634	1367	744	1300	1642	1414	1834
Petroleum Prdcts	7524	6923	6929	6732	6742	6637	5359	5722	5934	5731	5528	6122
Metallic Products & Scrap	2428	2654	2552	2401	2638	2705	2573	1692	2044	2070	2443	2880
All Other Commodities	3736	1964	654	1066	291	1842	1890	1203	330	42	87	81
TOTAL	45832	45274	42787	39812	37760	44119	39739	41550	43046	39156	38124	42298

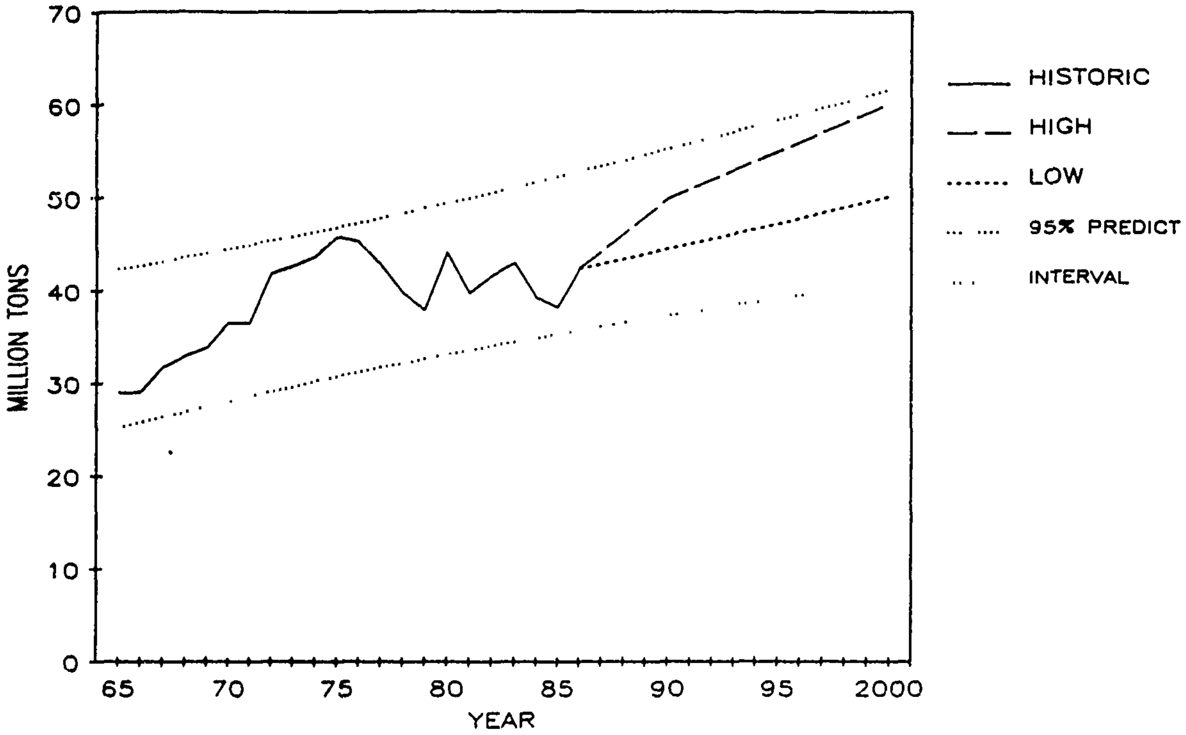
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-4-2
SEGMENT NUMBER 4
ILLINOIS WATERWAY TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-4-3
SEGMENT NUMBER 4
ILLINOIS WATERWAY TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-4-4
SEGMENT NUMBER 4
ILLINOIS WATERWAY

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
LaGrange L&D	30.5	-0.1%	28.5	30.0	30.3	12.0	18.3	3.2	3.2	3.0	1.5	1.5	8.8	9.5	10.0	8	9	10
Peoria L&D	28.8	-0.9%	26.6	28.8	26.4	12.1	14.3	3.4	3.5	3.1	1.5	1.6	7.9	8.0	8.5	8	8	8
Starved Rck L&D	22.1	-1.3%	20.0	21.5	19.3	10.2	9.1	3.0	3.2	2.8	1.4	1.4	6.7	6.8	6.9	6	7	7
Marseilles L&D	20.9	-1.7%	18.5	20.2	17.6	10.1	7.5	2.9	3.2	2.7	1.3	1.4	6.4	6.4	6.5	6	6	6
Dresden Island	20.6	-2.1%	17.2	19.1	16.7	11.0	5.7	3.0	3.3	2.8	1.4	1.4	5.7	5.9	6.0	5	6	6
Brandon Road	18.6	-2.5%	15.3	17.1	14.4	10.1	4.3	3.6	3.7	3.1	1.5	1.6	4.3	4.6	4.7	4	5	5
Lockport	20.7	-3.9%	14.7	16.8	13.9	10.0	3.9	3.6	3.8	3.1	1.5	1.6	4.1	4.4	4.6	4	5	5
T. J. O'Brien	8.7	-2.4%	5.9	6.2	6.8	3.3	3.5	2.3	2.3	2.4	1.2	1.2	2.5	2.7	2.8	2	3	3

SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-4-5
SEGMENT NUMBER 4
ILLINOIS WATERWAY

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ILLINOIS										
Ill Wwy	9,184	13,537	13,352	12,014	12,070	12,966	11,338	13,735	11,060	12,585
Subtotal	9,184	13,537	13,352	12,014	12,070	12,966	11,338	13,735	11,060	12,585

TON MILES OF TRAFFIC (000) CY 1977-1986

ILLINOIS										
Ill Wwy	8,046,639	7,611,067	7,001,156	8,293,686	8,056,952	7,808,859	8,726,974	7,863,873	7,748,053	8,505,870
Subtotal	8,046,639	7,611,067	7,001,156	8,293,686	8,056,952	7,808,859	8,726,974	7,863,873	7,748,053	8,505,870

O & M COSTS PER TON MILE ($) 1977-1986

ILLINOIS										
Ill Wwy	0.0011	0.0018	0.0019	0.0014	0.0015	0.0017	0.0013	0.0017	0.0014	0.0015
Segment	0.0011	0.0018	0.0019	0.0014	0.0015	0.0017	0.0013	0.0017	0.0014	0.0015

NOTE: FY 1987 costs in order by the waterway(s) above are 36,296 and the subtotal is 36,296.
1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

Table A-4-6
SEGMENT NUMBER 4
ILLINOIS WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
ILLINOIS WATERWAY								
Lockport	RC	1983	1987	22,700	0	22,700	100	0
Brandon Road	RCF	1984	1988	23,800	0	23,800	100	0
Dresden Island	RC	1978	1983	16,700	0	16,700	100	0
Marseilles	RCF	1985	1988	15,000	0	15,000	100	0
Starved Rock	RC	1978	1985	16,700	0	16,700	100	0
Peoria	RCF	1986	1990	21,200	0	7,570	36	6,000
La Grange	RCF	1986	1990	20,300	0	8,810	43	5,600

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-4-7
SEGMENT NUMBER 4
ILLINOIS WATERWAY

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Lagrange	1939	46	49	30.5	28.5	10.0	30.3	-6.0	-67.2	-0.7	65.9%	61.8%	54
Peoria	1939	44	52	28.8	26.6	11.1	26.4	-8.0	-61.5	-8.3	60.0%	50.8%	49
Starved Rock	1933	42	43	22.1	20.0	21.5	19.3	-10.0	-2.7	-12.7	46.0%	44.9%	45
Marseilles	1933	33	34	20.9	18.5	20.2	17.6	-11.0	-3.3	-15.8	53.3%	51.8%	52
Dresden Island	1933	38	39	20.6	17.2	19.1	16.7	-17.0	-7.3	-18.9	43.9%	42.8%	46
Brandon Road	1933	33	34	18.6	15.3	17.1	14.4	-18.0	-8.1	-22.6	43.6%	42.4%	48
Lockport	1933	33	33	20.7	14.7	16.8	13.9	-29.0	-18.8	-32.9	42.1%	42.1%	52
T J O'Brien	1960	27	37	8.7	5.9	6.2	6.8	-32.0	-28.7	-21.8	25.2%	18.4%	34

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 5
OHIO RIVER SYSTEM

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-5-1). This segment includes the Ohio River and seven tributaries.

(1) The Ohio River is formed by the junction of the Allegheny and Monongahela Rivers at Pittsburgh and flows generally southwestward for 981 miles to join the Mississippi River near Cairo, Illinois.

(2) The Tennessee River project includes 652 miles from the junction of the French Broad and Holston Rivers at Knoxville to the mouth at Paducah, Kentucky and about 61 miles on the Clinch River to Clinton, Tennessee. The system of dams permits navigation on tributaries other than the Clinch River, but they are not part of the Tennessee River project. Only traffic on the Tennessee River itself is subject to the fuel tax.

(3) The Cumberland River existing project extends from Celina, Tennessee, near the Kentucky state line, 385 miles to its mouth near Smithland, Kentucky and includes the nearly two mile long Barkley Canal. The Barkley Canal connects the Cumberland River above Barkley Lock and Dam with the Tennessee River above Kentucky Lock and Dam. The authorized project includes an unconstructed section from Celina to Wolf Creek Dam (mile 461). From there nine foot navigation does exist to the mouth of the Laurel River (mile 552). Only traffic on the portion below Cordell Hull Lock and Dam at Carthage (mile 314), Tennessee, is subject to the fuel tax.

(4) The Green and Barren Rivers project includes about 198 miles on the Green River from Mammouth Cave, Kentucky, to the mouth, about eight miles above Evansville, Indiana. The project also includes about 30 miles on the Barren River from Bowling Green, Kentucky, to its junction with the Green River (mile 150). The fuel taxed portion is from mile 149 (Lock and Dam 4) to the mouth, but commercial navigation is possible only to Lock and Dam 3 (mile 109), where lock operations were discontinued in 1981.

(5) The Kentucky River extends about 255 miles from its formation near Beattyville, Kentucky, but only the lower 82 miles to Lock and Dam 5 are operated and maintained for commercial navigation.

(6) The Kanawha River project extends from Deepwater, West Virginia (mile 91) to its mouth at Point Pleasant, West Virginia.

(7) The Monongahela River is formed by the junction of the Tygart and West Fork Rivers at Fairmont (mile 129), West Virginia, and flows north to Pittsburgh.

(8) The Allegheny River project extends 72 miles from East Brady, Pennsylvania, to Pittsburgh.

(9) Project depths on the Ohio System are nine feet throughout, except for six feet on the Kentucky River and 5 1/2 feet on the Green River from mile 103. Private interests dredged a nine foot channel from mile 103 to 108 on the Green River. Project widths are 300 feet on the Ohio, Tennessee, Kanawha, and Monongahela Rivers, 200 feet on the Green and Allegheny Rivers, 150 feet on the Cumberland River and 100 feet on the Kentucky River.

b. Locks (Table A-5-1).

(1) On the Ohio River sixteen of the twenty sites have main chambers 1200 feet long and 110 feet wide. The three upper most projects (Emsworth, Dashields, and Montgomery Locks and Dams) and Gallipolis Locks and Dam in midriver have 600 by 110 feet main chambers. The second chamber at the 16 sites is 600 feet long and 110 feet wide, except for Smithland Locks and Dam, which has a twin 1200 by 110 foot lock. The auxiliary locks at the four smaller sites are 360 foot long and 56 feet wide except for 110 feet wide at Gallipolis Locks and Dam. Lift ranges from 10 feet with 23 feet being the average. The larger locks are 8 to 29 years old while the smaller locks are 51 to 67 years old. At Locks and Dams 52 and 53 the new main chambers are only temporary locks and their auxiliary chambers are about 60 years old. The dams there are movable and permit navigable pass operations during high flow conditions.

(2) On the Tennessee River the first six locks are 110 by 600 foot (main locks), except Pickwicks main locks is 110 by 1200 foot. At the second of these, Pickwick Locks and Dam, a new 1000 by 110 foot lock has become the main chamber and the 600 by 110 foot lock is now the auxiliary chamber. Three of the first six locks have auxiliary locks 300 to 400 feet long and 60 feet wide and two, including the lowermost Kentucky Lock and Dam, have no second lock. The upper four smaller locks are 360 to 400 feet long and 60 to 75 feet wide. Lift averages 57 feet and ranges from 39 to 94 feet. Among the larger locks Kentucky Lock is the oldest at 46 years while the other five locks are five to 29 years old.

(3) The Cumberland River has two downriver locks that are 800 feet long and 110 feet wide and two upriver locks that are 400 by 84 feet wide. Ages are 15 to 36 years.

(4) The Green River's first two locks are 600 feet long and 84 feet wide with a lift of about 13 feet. They are 32 years old. Locks and Dams 3 and 4 are only 138 by 36 feet with a lift of 17 feet. Lock and Dam 1 on the Barren River has a 360 by 56 foot chamber. Green River Dam 4 failed and navigation through the locks ceased in 1965. Repairs have been deferred pending completion of the study. Navigation through Lock and Dam 1 on the Barren River was suspended in 1965 due to the loss of the lower pool in Green River Dam 4. Operations were discontinued at Lock 3 1981.

(5) The Kentucky River's first four locks are only 145 feet long and 38 feet wide with a lift of 8 to 14 feet. They are 144-149 years old. Federal operations at Locks and Dams 5-14 have ceased. The Water Resources Development Act of 1986 authorized transferr operational responsibility for those ten locks and dams to the Commonwealth of Kentucky. In 1988, the Kentucky general assembly authorized the Commonwealth to assume ownership of the Upper Kentucky. The Commonwealth plans to operate the project for recreational boating.

(6) The Kanawha River's three locks and dams have twin chambers that are 360 feet long and 56 feet wide with lifts of 24 to 28 feet. The locks are 51-54 years old.

(7) On the Monongahela River the four downriver locks and dams have dual chambers while the five upriver have one chamber. At the dual chamber sites lock length is 720 feet and widths are 110 or 84 feet at the two newer locks, but only 56 feet wide at Locks and Dams 3 and 4. The second chambers are 360 by 56 feet except at the fourth site, which has a twin 720 by 84 foot chamber. At the five single chamber sites, the three newer locks farthest upriver are

600 feet long and 84 feet wide, but the older Locks and Dams 7 and 8 are only 360 long and 56 feet wide. Lift is less than ten feet at the first two sites and averages nearly twenty feet at the other seven sites. The five newer locks and dams are 24 to 38 years old, but the older Locks and Dams 2,3,4,7 and 8 are 56 to 82 years old.

(8) The Allegheny River's eight 50 to 61 year old locks and dams have single chambers 360 feet long and 56 feet wide with lifts of about 12 feet at the first six locks and about 20 feet at the last two.

2. PERFORMANCE CHARACTERISTICS (Table A-5-2).

The 1987 total average processing time ranged anywhere from 16 minutes to 419 minutes (6.98 hours) and had a median value of 69 minutes. Total peak average processing time for the 1980-1987 time period ranged from 21 minutes (1985) at L&D 7 to 763 minutes or 12.72 hours (1986) at Racine and Gallipolis. The highest total peak average processing time from 1980 through 1987 was 763 minutes (12.72 hours) in 1986 for Racine and Gallipolis. Total delay for the locks where data was available for 1987 ranged from 0 hours to 27,523 hours. Total delay was generally high on the Ohio river, Monongahela river, Kanawha river and the lower Tennessee river. For the locks for which data was available the median total delay for 1987 was 639.5 hours. For the 1980-1987 time period, the peak total delay ranged from 0 at Allegheny to 42,898 hours (1986) at Gallipolis. From 1980 through 1987, the highest peak total delay occurred at Gallipolis in 1986 (42,898 hours). Lock utilization for 1987 varied from 0% to 86%, and the median lock utilization was 32%. The peak utilization rate from 1980 through 1987 ranged from 4% (1987) for Opekiska to 100% (1982) for Emsworth. In this segment, the highest peak utilization for the 1980-1987 time period was 100% at Emsworth. Total downtime for 1987 ranged from 0 hours to 6,652 hours. The median value was 65 hours and 23 locks had downtime quite in excess of this median. The peak total downtime hours from 1980 through 1987 varied from 0 hours to 8,080 hours in 1986 at London. The highest peak total downtime for 1980 through 1987 occurred in 1986 at London (8,080 hours). Total stall events for 1987 ranged from 0 to 344. The median value is 17.5 stall events and ten locks had stall events of over 100. The peak for total stall events from 1980 through 1987 varied from 0 to 360 at Smithland in 1980. From 1980 through 1987, Smithland had the highest peak total stall events of 360 in 1980.

3. COMMODITY TRAFFIC

<u>Ohio River System Overview</u>. (Tables A-2, A-5-3A,-4 and Figures A-5-2A,-3A).

a. <u>Historical</u>. Traffic on the Ohio River and its tributaries accounts for a significant portion of the over 500 million tons of commerce moving annually on the nation's inland waterways. The Ohio River system tonnage reached an all-time high in 1986 of over 222 million tons, 40 percent of the national total of 560 million tons. Traffic reported at individual locks on the lower Ohio during 1987 increased about 3 percent over 1986. Coal is by far the most significant commodity moving on the system, and coal tonnage reached a record 135.9 million tons in 1986 (61 percent of total traffic). Coal moving on the Ohio system is primarily for utility use, but coal for export through the Gulf has grown in importance. Non-metallic minerals, primarily aggregates used in the construction industry, is the next most important group in terms of

tonnage. This commodity's tonnage has been cyclical, growing from 23.6 million tons in 1975 to a peak of nearly 31 million by 1979, then declining to 20.5 million tons in 1982 before reaching a new peak of 31.3 million tons in 1986. Petroleum products tonnage is also significant, but, as on other inland waterways, it has generally declined over the last decade. Petroleum products peaked at nearly 23 million tons in 1978. Tonnage in 1986 was 17.1 million. Grain and oilseed traffic, while variable, has generally been increasing. It has grown from just over 4 million tons in 1975 to a peak in 1985 of 12.2 million tons, then declined to 10 million tons in 1986. Industrial chemicals are also important and have varied between a high of 10.9 million tons in 1979 and a low of 7.6 million tons during 1982. Tonnage in 1986 was 9.6 million.

b. Forecast. Between 1986 and 2000, waterborne traffic on the Ohio River System is projected to increase at an average annual rate of 1.3 to 2.8 percent, growing from 222.2 million tons to between 266.8 and 327.0 million tons by 2000. Coal accounted for 61 percent of all tons in 1986 and exerts by far the greatest influence on traffic forecasts. Because of gradually increasing demands for coal for power generation by electric utilities, coal movements on the Ohio River System are projected to grow considerably by the turn of the century.

Ohio River-Main Stem (Tables A-5-3B, and Figure A-5-2B,-3B).

a. Historical. The Ohio River mainstem carries about 88 percent of the tonnage on the Ohio River system, with its tributaries feeding additional traffic to the waterway. The Ohio River has experienced slow but relatively steady growth in traffic since the mid 1960s, with some decline during the recession of the early 1980s. Boosted by dramatic growth in coal, total tonnage on the mainstem reached a high of over 195.6 million tons in 1986, an increase of over 18 million tons from 1985. This represents an average annual growth rate of 3.3 percent from the 1965 traffic level of 103 million tons. Coal is the dominant commodity moving on the river (nearly 59 percent of total traffic), and it principally serves the utility industry. Coal traffic has generally been increasing, with some retreat during the strike year of 1978 and during the recent recession. Overall, coal grew from less than 73 million tons in 1975 to a record of nearly 115 million in 1986. Many other commodities also move on the Ohio, but in much smaller volumes than coal. The next leading commodity groups and their 1986 tonnages are: nonmetallic minerals and products (27.4 million); petroleum products (16.9 million); and farm products (12.4 million).

b. Forecast. Waterborne traffic on the main stem of the Ohio River is projected to grow from 195.6 million tons to between 233.7 and 287.7 million tons by 2000. Accounting for 61 percent of all tons in 1986, coal is the major commodity influencing projections. Increased out-year demand for coal by electric utilities for power generation is the determining factor in coal traffic forecasts, although the steel industry and export markets could also influence demand.

c. Tonnages at Locks. Based on average annual percent change during the 1977-1987 period average annual tonnage increase at individual locks varied from 0.3% (Dashields) to 4.0% (New Cumberland). Four locks showed a

negligible decline in tonnage (Willow Island, Belleville, Racine and Gallipolis). Tonnage increases between 1977 and 1987 ranged from 2.2 million tons (Emsworth) to 24.7 million tons (Lock and Dam 52).

Monongahela River (Tables A-5-3C, and Figure A-5-2C,-3C).

a. Historical. This waterway has historically been a major mover of coal from the mines of West Virginia and Pennsylvania to utility and steel industries downriver and on the Ohio. Total traffic has tended downward in recent years, reflecting the decline of the regional steel industry as well as the relatively higher cost to shippers of using a waterway with antiquated lock dimensions. Tonnage in 1986 was 29.5 million, of which coal accounted for 25.4 million (86 percent). Other commodities move in much lesser volumes and have likewise declined with the economic slump of the region. Petroleum products declined from 2.6 million tons in 1975 to 1.3 million in 1986, while metallic ores, products and scrap declined from nearly 2 million tons to less than 0.4 million over the same period. Nonmetallic minerals and products have generally hovered around 2 million tons since 1975.

b. Forecast. Waterborne commerce on the Monongahela River is projected to increase modestly between 1986 and 2000. These growth rates would result in the expansion of traffic from the depressed level of 29.5 million tons in 1986 to between 43.1 and 56.6 million tons by 2000. Likely future volumes could range considerably higher or lower than these projections suggest.

c. Tonnages at Locks. Based on average annual percent change Opekiska experienced the highest percentage growth in tonnage of 21.5% during the 1977-1987 period. For the same period, total tonnage increased at all the locks ranging from 0.6 million tons (Opekiska) to 1.9 million tons (Lock and Dam 2). Actual 1987 tonnage ranged from 0.7 million tons (Opekiska) to 19.9 million tons (Lock and Dam 3).

Kanawha River (Tables A-5-3D, and Figure A-5-2D,-3D).

a. Historical. Traffic on the Kanawha River of West Virginia reached a new record in 1986 of 18.2 million tons, passing the old peak of nearly 14.7 million in 1980. Coal is by far the dominant commodity, with 1986 volume at an all-time high of 12.7 million tons (76 percent of total traffic). Industrial chemicals have also been important historically. Nonmetallic minerals and products on the Kanawha have averaged about 2.1 million tons per year over the last decade. Tonnage in 1986 was just over 2 million.

b. Forecast. Waterborne commerce on the Kanawha River is projected to increase from 16.8 million tons to between 21.2 and 28.4 million tons by 2000. These forecasts anticipate slower growth rates of 1.7 to 3.8 percent, which bracket the historic rate of 2.8 percent between 1975 and 1986. Accounting for 76 percent of tonnage in 1986, coal is the dominant commodity influencing future traffic forecasts.

c. Tonnages at Locks. Based on average annual percent change during the 1977-1987 period, all three locks on this river experienced growth in tonnage (4.7% to 10.8%). For 1987, tonnage increase ranged from 2.4 million tons

(London) to 6.4 million tons (Winfield) over 1977 levels. Total tonnage ranges from 3.9 million tons for London to 17.3 million tons for Winfield in 1987.

Cumberland River (Tables A-5-3E, and Figure A-5-2E,-3E).

a. Historical. Although not as heavily used as the Monongahela and the Tennessee, the Cumberland River of Kentucky and Tennessee still contributes a substantial amount of traffic to the Ohio River System. Total tonnage peaked in 1979 at approximately 15.2 million tons, due in large part to record coal movements. Traffic declined and levelled off in the early 1980s before rebounding again in 1984 and 1985, reaching 14.1 and 14.2 million tons, respectively. Overall, traffic has grown at an average annual rate of 1.8 percent since 1975. Total tonnage was dramatically higher in 1986 due to the diversion of Tennessee River traffic while major rehabilitation took place at Kentucky Lock. Therefore 1986 tonnage figures have not been used for historical or forecast analyses. Traffic at Cheatham Lock, upriver from the diversion area, grew 7.3% between 1985 and 1986 and 11.4% between 1986 and 1987, and is probably more representative of general trends on the river. The major commodities transported on the Cumberland River are coal (37.7 percent of total tons in 1985), nonmetallic minerals and products (38.8 percent), and petroleum products (3.8 percent). Coal (nearly all inbound) was traditionally the Cumberland's major commodity until 1985, when inbound nonmetallic mineral traffic surged and lifted that commodity group to the number one position. For the last ten years coal movements have fluctuated between 4.6 and 6.9 million tons, while nonmetallic mineral movements have increased from 2.6 to 5.5 million tons during the same period. Petroleum products have declined over the last ten years, falling from 1.2 million tons in 1975 to .3 million tons in 1981 before recovering somewhat to .5 million tons in 1985.

b. Forecast. Waterborne commerce on the Cumberland River is projected to increase from 14.2 million tons in 1985 to between 17.0 and 23.7 million tons by 2000. The Cumberland's two major commodities make up nearly equal shares of traffic: coal (38 percent of 1985 tons) and nonmetallic minerals and products (39 percent). Together they exert the greatest influence on future traffic forecasts. As stated previously, coal traffic is projected to grow moderately as a result of electric utilities' increasing power production. Nonmetallic minerals and products movements will fluctuate yearly with construction activity, but are projected to decline from the traffic levels of 1985.

c. Tonnages at Locks. Based on average annual percent change during the 1977-1987 period, tonnage increased at all the locks on this river, varying from 0.2% (Barkley) to 7.2% (Old Hickory) per annum. For 1987, actual tonnage levels ranged from 0.8 million tons (Old Hickory) to 5.0 million tons (Barkley). The 4.9 million tons at Cheatham was an 11.4% increase over 1986 levels.

Tennessee River (Tables A-5-3F, and Figure A-5-2F,-3F).

a. Historical. Waterborne commerce on the Tennessee River reached an all-time high of 42.1 million tons in 1986, higher than any of the other Ohio River tributaries. Since 1982, growth has been due primarily to coal, which

increased from 12.7 million tons in 1981 to over 21.5 million by 1985 (54 percent of total traffic). Traffic in nonmetallic minerals and products has also experienced renewed growth since the 1982 low of 2.8 million tons, increasing to over 5.7 million tons in 1985. Farm products, particularly grain and soybeans, experienced an average annual growth rate of 7.9 percent between 1975 and 1986. Traffic reached a peak in 1984 at 4.7 million tons, then declined somewhat to 4 million tons in 1985 before recovering again to 4.5 million tons in 1986. Other principal commodities include petroleum products and industrial chemicals. Petroleum products reached 2.3 million tons in 1986, the highest level since 1979.

b. Forecast. Waterborne traffic on the Tennessee River is projected to range between 47.1 and 56.6 million tons by 2000. In spite of significant growth, even the highest projected growth rate is lower than the 3.1 percent average annual growth rate of the 1975-86 period, largely because of a slower growth rate in coal traffic in the near-term as nuclear plants in the region come on line. Accounting for 54 percent of tonnage in 1986, coal is the major commodity influencing future traffic forecasts. Of the other important commodities on the Tennessee River, growth of nonmetallic minerals and products traffic should remain relatively flat, while farm products traffic is projected to increase.

c. Tonnages at Locks. Based on average annual percent change during the 1977-1987 period, all locks, except Wilson (-0.9%) and Wheeler (-1.0%), showed growth in tonnage varying from 0.7% (Guntersville) to 12.2% (Watts Bar). For the same period, actual tonnage increase ranged from 0.3 million tons at Ft. Loudon to 10.1 million tons at Kentucky which recovered from low levels in 1986 when it was closed part of the year for major rehabilitation. The range of total tonnage for 1987 by lock is from 0.6 million tons (Ft. Loudon) to 30.1 million tons (Kentucky).

4. OPERATION AND MAINTENANCE COSTS (Table A-5-5).

O&M outlays increased from about $43 million in 1977 to about $87 million in 1986, or about a 21% increase in real terms when adjusted for about 68% inflation from 1977 to 1986. Traffic increased from about 46 billion ton-miles to 62 billion ton-miles during the same period. O&M costs per ton-mile increased from 0.9 mills in 1977 to 1.4 mills in 1986. This segment ranked the third lowest of all nine segments in cost per ton-mile.

5. PROGRAM STATUS (Table A-5-6).

a. Overview. During the late 1970s and the 1980s the Ohio River System has been improved by an almost equal number of construction and rehabilitation projects. Of those projects underway in the 1980s six are construction and five are rehabilitation projects. Two construction projects (Smithland and Pickwick Locks and Dams) became operational in the first half of the decade. The other four, authorized in 1986, are scheduled to begin construction in the late 1980s and to be completed and become operational in the early and middle 1990s. Of the five rehabilitation projects, all on the Ohio River, three are complete and the other two will be complete by 1991.

There are potentially 12 locks and dam projects and one channel project that could be ready for construction in the 1990s on four of the eight

waterway sub-systems. The construction work depends on the results of six planning studies scheduled for completion by 1993, subsequent project authorization, and appropriation of funds by Congress.

b. Ohio River. There are currently two construction projects, two major rehabilitation projects, and three studies, one of which is for preconstruction engineering and design (PED).

(1). Smithland Locks and Dam is being completed in 1988 at a cost of $274.1 million. Its twin 1200 foot long and 110 foot wide chambers on the lower river were operational in 1980.

(2). Gallipolis Locks and Dam was authorized in 1987, and the estimated $336 million project is scheduled to be completed in 1995 after the locks are completed in 1991. The project will have a new 1200 by 110 foot main chamber and a 600 by 110 foot auxiliary chamber constructed inland of the existing locks, to maintain traffic during construction and to provide better lock approach conditions. The project is 20 percent complete and will be 38 percent complete with funds requested for FY 1989. Work in 1988 and 1989 includes and continuation of lock and canal construction (about 85 percent of costs) and continuation of land acquisition.

(3). Emsworth, Dashields and Montgomery Locks and Dams. These structures, built between 1921 and 1936, are the last on the Ohio River with small 600 feet long main lock chambers. They are unable to lock the typical 15 barge Ohio River tow in a single lockage. Montgomery and Dashields Locks and Dams are undergoing major rehabilitation that is scheduled to be completed in 1988 and 1991. Completion at Dashields is 39 percent this year and 66 percent with funds requested for FY 1989. Rehabilitation work at Montgomery and Dashields Locks and Dams involves restoration of lock walls, installing new lock gates, replacement of mechanical and electrical equipment associated with operation of the dam and locks, structural repairs to and replacement of several dam components, and correction of undercutting problems around the base of Dashields Dam. Major rehabilitation of Emsworth Locks and Dam was completed in 1985. The total cost for rehabilitating the three projects is estimated to be $104.1 million. A study examining the three undersized and old facilities, 80 percent complete this year, will be completed in 1990. Preliminary studies indicate that the most favorable plan is to rehabilitate or replace the dams and replace the locks with 110 by 1200 foot chambers at a cost of $693 million.

(4). Construction of Olmsted Locks and Dam to replace Locks and Dams 52 and 53 was authorized in 1988. Estimated cost for the project, consisting of twin chambers 1200 feet long and 110 feet wide and a dam that includes a 1,120 foot wide navigable pass section, is $775 million.
Preconstruction engineering and design on Olmsted Locks and Dam, 26 percent complete this year, will be completed in 1992 at a cost of $20.9 million. Temporary 1200 by 110 foot locks were completed at Locks and Dams 52 and 53 in 1969 and 1980 respectively to permit transit of 15 barge tows with one lockage. Both dams are designed with a navigation pass which, during periods of sufficient flow (about 60% of the time) can be used to provide navigation through the dam. The temporary locks are affected by deflection of the cells,

which affects the safety of the locks and lock filling and emptying times are extremely long. To ensure continued navigation until the Olmsted project is in place, interim rehabilitation of Locks and Dams 52 and 53 was completed in 1986 for a total of $13.4 million.

(5). McAlpine Locks and Dam is the focus of a continuing study of the Lower Ohio River. The project in Louisville has three locks with sizes of 1200 and 600 feet by 110 feet and 360 feet by 56 feet. The largest chamber is only 27 years old but the auxiliary chambers are 67 and 58 years old (The latter is inoperable.). Problems at McAlpine L&D include increasing congestion, operation and navigation complexities associated with a canal and several bridges, and an inefficient and obsolete 110 by 600 foot auxiliary chamber that essentially reduces the McAlpine facility to a single chamber project. Current feasibility studies indicate that an additional 110 by 1200 foot chamber at a cost of approximately $200 - $250 million is needed by the year 2000. The feasibility study will be completed in FY 89 and the project will be eligible for Planning, Engineering and Design (PED) in FY 90.

c. Monongahela River. There are two construction projects, a recently completed major rehabilitation project, and a study of the downriver locks and dam.

(1). Locks and Dams 7 and 8 at Grays Landing and Point Marion about 85 and 91 miles above the river mouth will have their old, 360 by 56 foot locks replaced with 720 foot long and 84 foot wide chambers compatible with other new locks on the river. Point Marion's estimated cost is $82.9 million, while the estimated cost of Grays Landing, where the dam will also be replaced, is $167.2 million. At Grays Landing the lock will be completed in 1993 and the entire project in 1995. It is 6 percent complete this year and will be 15 percent complete with funds requested for FY 1989. Work in 1988 and 1989 includes initiation and continuation of bank excavation (about 55% of costs) and coordination of land acquisition. However, Point Marion Lock and Dam is only 1 percent complete and is scheduled to begin construction in FY 1990.

(2). Locks and Dams 2, 3, and 4 are being studied to determine what navigation structure improvements are needed for the aged and deteriorating facilities. The condition and size of these locks are a major impediment to low cost water transportation in the Monongahela Valley. Replacement and/or rehabilitation will be needed in the near future. Early study results indicate that replacing existing narrow 56 foot chambers with 84 by 720 foot locks and rehabilitation or replacement of the dams is needed and feasible at a cost of $350 million. Study completion is scheduled for FY 90. FY 89 funds will be used to substantially complete a preliminary draft feasibility report. Major rehabilitation of Locks and Dam 3 was completed in 1980 at a cost of $16.0 million.

d. Kanawha River. One project is under construction and two old, small locks are under study for replacement.

(1). Winfield Locks and Dam, the busiest project in the inland navigation system in terms of lockages, is under construction to provide an

800 foot long and 110 foot wide lock landward of the 51 year old, twin 360 by 56 foot chambers. The scheduled completion date for the estimated $153 million project is indefinite. It is 2 percent complete this year and will be 6 percent complete with funds requested for FY 1989. Work in 1988 and 1989 includes continuation of land acquisition (about 50% of costs) as well as engineering and design.

(2). Marmet Lock and Dam, which is 53 years old, is the second busiest lock in the Ohio River system, due to its small twin 56 by 360 foot chambers which can only process one modern "Jumbo" barge at a time. Preliminary assessment indicates that replacing one of the chambers with a larger lock is feasible at a cost of about $150 million. The study is presently scheduled for completion in FY 90. Preconstruction Engineering and Design would begin in FY 91. The study of London, only 15 percent complete this year, is scheduled for completion in 1992.

e. Kentucky River. The navigation interim study on modernization of the lower 85 miles of the Kentucky River has been discontinued. Locks and Dams 1 through 4 are only 145 feet long and 38 feet wide single chambers over 140 years old. The channel is only six foot deep. The 1986 Water Resources Development Act authorized disposal of Locks and Dams 5 through 14 to the Commonwealth of Kentucky without and y construction cost.

f. Green River and Barren Rivers. Further studies of the Green River Navigation Project are deferred and not presently scheduled for completion. In FY 89, funds were appropriated for a reconnaissance report on navigation modernization. Local interests desire restoration of navigation to Bowling Green, Kentucky, through construction of a multipurpose lake with a navigation lock.

g. Cumberland River.

(1) Ten narrow tight bends on the lower Cumberland River discourage industry from using the Barkley Lock and Dam. The congested Kentucky Lock and Dam on the Lower Tennessee River is the preferred route. Preliminary indications are that widening critical bendways and constructing and additional lock at Kentucky Lock and Dam will be required. Study completion is now scheduled in FY 90.

(2) Construction of the authorized Celina Dam for about $213 million (1984 estimate) at the Kentucky-Tennessee state line would provide for the inclusion of a 400 by 84 foot lock for about $39 million (1959 estimate) when it is warranted. Neither this inactive project nor consideration of a barge lock or lift at Wolf Creek Dam 80 miles upriver is being included in the Cumberland-Tennessee Rivers study.

h. Tennessee River. Kentucky Lock and Dam will be included in late 1988 Cumberland-Tennessee Rivers Below Barkley Canal Interim Report because of potential increased traffic stemming from: (1) increasing Cumberland River traffic using Barkley Canal and Kentucky Lock rather than the Lower Cumberland River, (2) increasing Tennessee River traffic, and (3) new traffic using the Tennessee-Tombigbee Waterway.

(2). Pickwick Locks and Dam opened in 1984 with a new 1000 foot long and 110 foot wide main chamber constructed for $127.8 by the Tennessee Valley Authority a few miles downriver from the Tennessee-Tombigbee Waterway's junction with the Tennessee River.

(3) The middle Tennessee River, with a 600 by 110 foot main or single chamber lock at Wilson, Wheeler, Guntersville, and Nickajack Locks and Dams, is included in the Cumberland-Tennessee Rivers study. They will be discussed in the 1993 main report.

(4). Chickamauga, Watts Bar, and Fort Loudon Locks and Dams, with 45 to 48 year old single chambers of 360 by 60 feet, will be the focus of a 1992 interim study report on the upper Tennessee River. These projects are not large enough to handle the modern Tennessee River tow of up to 15 barges causing excessive delays and hampering the development of natural resources and industrial potential upstream of Chattanooga, TN. Preliminary reconnaissance level studies indicate that new 110 by 600 foot locks at each of these facilities would significantly reduce these congestion problems. Consideration is being given to 600 by 110 foot chambers that would be compatible with locks downriver.

6. LOCK CAPACITY CHARACTERISTICS (Table A-5-7).

The source of capacity range data is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-5-4.

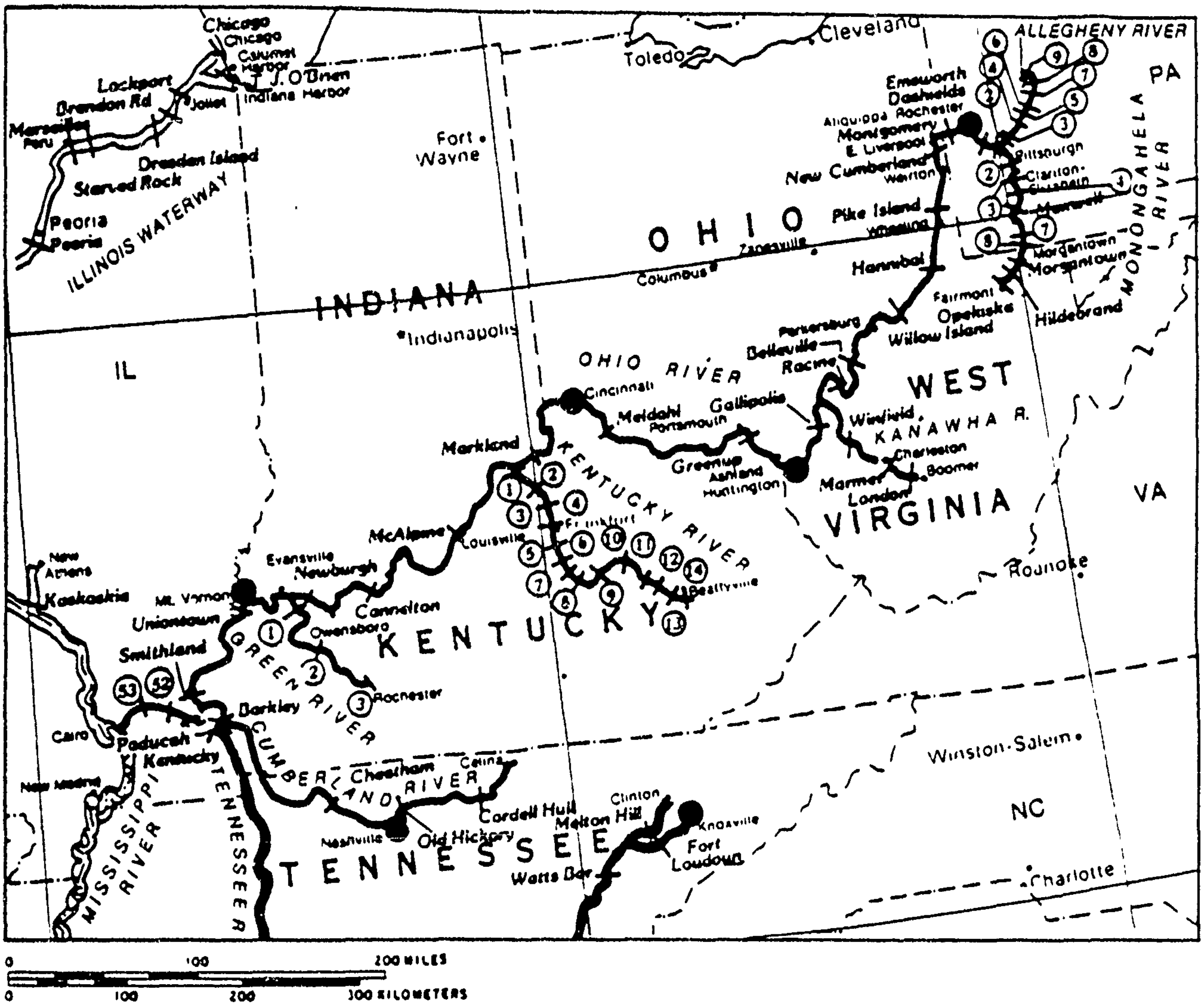


Figure A-5-1
Segment 5, Ohio River System

TABLE A-5-1
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	MILES ABOVE MOUTH	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Ohio River						
Emsworth	974.8	1921	67	110	600	18
		1921	67	56	360	18
Dashields	967.7	1929	59	110	600	10
		1929	59	56	360	10
Montgomery	949.3	1936	52	110	600	18
		1936	52	56	360	18
New Cumberland	926.6	1959	29	110	1200	21
		1959	29	110	600	21
Pike Island	896.7	1965	20	110	1200	21
		1965	20	110	600	21
Hannibal	854.6	1973	16	110	1200	21
		1973	16	110	600	21
Willow Island	819.3	1973	16	110	1200	20
		1973	16	110	600	20
Belleville	777.1	1969	20	110	1200	22
		1969	20	110	600	22
Racine	743.5	1970	17	110	1200	22
		1970	17	110	600	22
Gallipolis	701.8	1937	51	110	600	23
		1937	51	110	360	23
Gallipolis (u. const)	279.2	1991	----	110	1200	23
		1991	----	110	600	23
Greenup	640.0	1959	29	110	1200	30
		1959	29	110	600	30
Meldahl	544.8	1962	26	110	1200	30
		1962	26	110	600	30
Markland	449.5	1963	25	110	1200	35
		1963	25	110	600	35
McAlpine	374.2	1961	27	110	1200	37
		1921	67	110	600	37
		1930*	58	56	360	37
Cannelton	260.3	1972	16	110	1200	25
		1972	16	110	600	25
Newburgh	204.9	1975	13	110	1200	16
		1975	13	110	600	16
Uniontown	135.0	1975	13	110	1200	18
		1975	13	110	600	18
Smithland	35.3	1980	8	110	1200	22
		1980	8	110	1200	22

TABLE A-5-1(Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	MILES ABOVE MOUTH	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	LENGTH (FEET)	LIFT (FEET)
L&D 52	42.1	1969	19	110	1200(T)	12
		1928	60	110	600	12
L&D 53	18.4	1980	8	110	1200(T)	12
		1929	59	110	600	12
Olmsted (PED)	17.6	----	---	110	1200	---
	----	----	---	110	1200	---
Monongahela River						
L&D 2*	11.2	1951	37	110	720	9
		1953	82	56	360	9
L&D 3	23.8	1907	81	56	720	8
		1907	81	56	360	8
L&D 4	41.5	1932	56	56	720	17
		1932	56	56	360	17
Maxwell	61.2	1964	24	84	720	20
		1964	24	84	720	20
Grays Landing (L&D 7)	85.0	1925	63	56	360	15
Grays Landng (u.const)	82.0	1993	---	84	720	15
Pt. Marion (L&D 8)	90.8	1925	63	56	360	19
Pt. Marion (u. const)	90.8	----	---	84	720	19
Morgantown	102.0	1950	38	84	600	17
Hildebrand	108.0	1959	29	84	600	21
Opekiska	115.4	1964	24	84	600	22
Allegheny River						
L&D 2	6.7	1934	54	56	360	11
L&D 3	14.5	1934	54	56	360	14
L&D 4	24.2	1927	61	56	360	11
L&D 5	30.4	1927	61	56	360	12
L&D 6	36.3	1928	60	56	360	12
L&D 7	45.7	1930	58	56	360	13
L&D 8	52.6	1931	57		360	18
L&D 9	62.2	1938	50	56	360	22
Kanawha River						
Winfield	31.1	1937	51	56	360	28
		1937	51	56	360	28

(T) Temporary locks
* The project was built in 1906; a new 110 by 720 lock use added in 1951, and the 360-ft lock was rebuilt in 1953.

TABLE A-5-1 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	MILES ABOVE MOUTH	YEAR OPENED	AGE AS OF 1988	CHAMBERS		
				WIDTH (FEET)	LENGTH (FEET)	LIFT (FEET)
Winfield (u. const.)	-----	-----	--	110	800	28
Marmet	67.8	1934	54	56	360	24
		1934	54	56	360	24
London	82.8	1934	54	56	360	24
		1934	54	56	360	24
Kentucky River						
L&D 1	4.0	1839	149	38	145	8
L&D 2	31.0	1839	149	38	145	14
L&D 3	42.0	1844	144	38	145	13
L&D 4	65.0	1844	144	38	145	13
Green/Barren Rivers						
L&D 1	9.1	1956	32	84	600	12
L&D 2	63.1	1956	32	84	600	14
L&D 3*	108.5	1836	152	36	138	17
		-----	-----	--	---	--
L&D 4*	149.0	1836	152	36	138	17
L&D 1* (Barren R.)	15.0	1934	54	56	360	--
Cumberland River						
Barkley	30.6	1964	24	110	800	57
Cheatham	148.7	1952	36	110	800	25
Old Hickory	216.2	1954	34	84	400	60
Cordell Hull	313.5	1973	15	84	400	59
Tennessee/Clinch Rivers						
Kentucky	22.4	1942	46	110	600	56
Pickwick	206.7	1937	51	110	600	55
(u. const.)		1984	5	110	1000	55
Wilson	259.4	1927	61	60	300	94
		1927	61	60	292	--
		1959	29	110	600	94
Wheeler	274.9	1963	25	110	600	48
		1934	54	60	400	48

TABLE A-5-1(Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	MILES ABOVE MOUTH	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Guntersville	349.0	1965	23	110	600	39
		1937	51	60	360	39
Nickajack	424.7	1967	21	110	600	39
Chickamauga	471.0	1937	51	60	360	49
Watts Bar	529.9	1941	47	60	360	58
Ft. Loudon	602.3	1943	45	60	360	72
Melton Hill (Clnch R.)	23.1	1963	25	75	400	58

* - Not operational
Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986

TABLE A-5-2

SEGMENT NUMBER 5

OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK* (PEAK YEAR)	AVERAGE PROCESSING TIME PER TOW						TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	DELAY** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)					
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Ohio River										
Emsworth	54 (81)	25	55 (87)	55	103 (81)	80	11860 (81)	1730	100 (82)	63
Dashields	37 (81)	30	62 (87)	62	94 (85)	91	5230 (85)	1965	64 (80)	57
Montgomery	104 (87)	104	68 (87)	68	157 (87)	157	18445 (86)	7383	100 (86)	N.A.
New Cumberland	13 (82)	12	56 (87)	56	68 (87)	68	1806 (80)	634	59 (82)	50
Pike Island	14 (86)	11	52 (87)	52	64 (85)	61	1039 (84)	621	82 (86)	44
Hannibal	16 (82)	12	56 (83)	53	71 (86)	65	1277 (83)	605	49 (84)	33
Willow Island	30 (84)	10	50 (87)	50	92 (84)	60	3540 (87)	3540	25 (86)	0
Belleville	35 (81)	9	52 (87)	52	88 (83)	61	2585 (84)	467	25 (86)	19
Racine	40 (83)	18	53 (87)	53	763 (86)	71	2368 (83)	1631	24 (85)	17
Gallipolis	665 (86)	291	105 (86)	101	763 (86)	392	42898 (86)	20608	62 (86)	43
Greenup	47 (86)	19	53 (83)	48	92 (86)	67	4240 (86)	1489	34 (86)	25
Meldahl	200 (87)	200	69 (87)	69	269 (87)	269	14387 (87)	14387	45 (87)	45
Markland	87 (85)	32	63 (85)	55	167 (85)	87	6234 (85)	2509	47 (80)	21
McAlpine	296 (87)	296	61 (80)	60	356 (87)	356	26186 (87)	26186	76 (85)	65
Cannelton	403 (86)	56	62 (86)	57	465 (86)	113	35685 (86)	4914	64 (81)	32
Newburgh	34 (80)	24	47 (87)	47	82 (85)	71	6102 (80)	2740	55 (81)	36
Uniontown	67 (80)	31	46 (85)	45	113 (80)	76	4173 (85)	3528	47 (80)	34
Smithland	381 (80)	6	47 (87)	47	81 (80)	55	7764 (80)	791	45 (80)	37
L&D 52	169 (87)	169	67 (82)	47	496 (82)	216	27523 (87)	27523	100 (80)	59
L&D 53	DATA NOT AVAILABLE									

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK* (PEAK YEAR)	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
Monongahela River										
L&D 2	19 (81)	15	44 (84)	43	61 (84)	59	1687 (80)	1065	53 (87)	53
L&D 3	30 (80)	16	34 (87)	34	60 (80)	50	6125 (80)	1675	98 (80)	59
L&D 4	22 (87)	22	48 (87)	48	69 (87)	69	3281 (85)	1720	55 (87)	55
Maxwell	5 (84)	2	36 (81)	35	40 (84)	37	397 (84)	249	53 (87)	53
L&D 7	39 (87)	39	57 (86)	53	92 (87)	92	3317 (87)	3317	59 (87)	59
L&D 8	22 (85)	21	53 (81)	48	70 (86)	69	1553 (87)	1553	48 (87)	48
Morgantown	2 (87)	2	29 (81)	27	29 (87)	29	41 (87)	41	10 (87)	10
Hildebrand	2 (85)	1	31 (85)	30	33 (87)	33	10 (85)	6	5 (87)	5
Opekiska	2 (87)	2	26 (86)	25	29 (87)	29	10 (87)	10	4 (87)	4
Allegheny River										
L&D 2	12 (85)	9	31 (80)	26	40 (80)	33	416 (80)	256	35 (86)	26
L&D 3	12 (85)	8	32 (85)	29	42 (85)	36	375 (85)	255	25 (85)	23
L&D 4	7 (80)	3	32 (84)	25	37 (84)	28	247 (80)	73	21 (85)	17
L&D 5	2 (86)	1	22 (87)	22	24 (87)	24	27 (80)	14	12 (85)	8
L&D 6	13 (80)	1	24 (84)	20	27 (84)	23	33 (85)	6	10 (85)	4
L&D 7	2 (85)	1	19 (84)	18	21 (85)	20	3 (85)	2	5 (87)	5
L&D 8	0***	0	21 (82)	17	24 (80)	20	4 (85)	0	7 (82)	3
L&D 9	0	0	19 (80)	16	21 (81)	19	0	0	4 (84)	3

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
Kanawha River										
Winfield	341 (85)	244	176 (86)	172	478 (85)	416	25201 (85)	13066	81 (87)	81
Marmet	58 (83)	35	152 (86)	148	218 (86)	183	4035 (86)	3300	54 (86)	48
London	186 (84)	39	106 (86)	101	237 (84)	140	5095 (84)	2267	26 (86)	21
Kentucky River										
L&D 1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Green River										
L&D 1	6 (84)	3	24 (81)	21	56 (81)	24	3552 (81)	157	100 (81)	14
L&D 2	3 (84)	2	27 (86)	26	31 (81)	28	132 (84)	82	71 (80)	13
Cumberland River										
Barkley	211 (86)	15	91 (80)	60	287 (86)	75	795 (86)	341	42 (86)	21
Cheatham	68 (84)	11	57 (81)	51	120 (84)	62	903 (84)	213	21 (86)	12
Old Hickory	67 (83)	9	51 (87)	51	115 (83)	60	401 (83)	88	20 (86)	18
Cordell Hull	25 (85)	N.A.	50 (85)	N.A.	75 (85)	N.A.	58 (85)	N.A.	85 (86)	N.A.

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
Tennessee/Clinch River										
Kentucky	247 (87)	247	109 (87)	109	356 (87)	356	15786 (87)	15786	86 (87)	86
Pickwick	139 (87)	130	108 (83)	101	231 (87)	231	5448 (87)	5448	71 (85)	50
Wilson	166 (82)	27	115 (83)	93	324 (83)	120	4950 (83)	645	66 (81)	37
Wheeler	54 (85)	20	103 (86)	101	149 (85)	121	1040 (85)	354	57 (86)	22
Guntersville	113 (80)	16	89 (84)	76	197 (80)	92	1613 (80)	271	37 (85)	32
Nickajack	28 (82)	16	71 (80)	67	96 (80)	83	490 (82)	333	27 (86)	21
Chickamauga	168 (84)	104	338 (81)	315	419 (87)	419	1461 (84)	1365	52 (87)	52
Watts Bar	93 (85)	42	290 (87)	290	332 (87)	332	665 (85)	275	29 (87)	29
Ft. Loudon	55 (80)	17	201 (80)	171	256 (80)	188	245 (87)	245	22 (85)	17
Melton Hill	106 (85)	0	42 (87)	42	128 (85)	42	85 (85)	0	43 (86)	39

* Peak is the year with the highest value for 1980 through 1987, with the year of occurrence in parenthesis.
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year
*** Zero indicates that no data is available.
N.A. = Not Available
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-5-2
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Ohio River																
Emsworth	647 (83)	9	348 (86)	105	279 (83)	4	999 (83)	118	72 (82)	6	103 (82)	4	99 (83)	4	189 (83)	14
Dashields	480 (85)	44	236 (83)	5	165 (82)	25	617 (85)	74	29 (85)	3	44 (82)	4	22 (85)	13	65 (85)	20
Montgomery	4252 (87)	4252	231 (85)	10	2386 (87)	2386	6652 (87)	6652	61 (86)	39	69 (82)	6**	98 (87)	98	142 (87)	142
New Cumberland	558 (84)	12	803 (85)	1	132 (86)	19	1175 (85)	31	18 (80)	2	11 (82)	0	7 (87)	7	33 (85)	9
Pike Island	1702 (86)	193	787 (85)	0	244 (85)	28	2526 (86)	221	17 (86)	8	10 (82)	0	10 (85)	3	30 (86)	11
Hannibal	1402 (85)	752	1746 (85)	0	757 (86)	17	3222 (85)	769	53 (87)	53	32 (82)	0	12 (80)	4	61 (85)	57
Willow Island	537 (83)	2	516 (85)	0	707 (85)	63	1200 (84)	65	21 (83)	2	17 (82)	0	10 (84)	4	25 (83)	6
Belleville	1554 (81)	4	720 (85)	3	437 (84)	1	1567 (81)	8	10 (80)	4	16 (82)	1	13 (84)	1	31 (84)	6
Racine	1546 (83)	972	529 (85)	5	99 (85)	31	1560 (83)	1008	70 (83)	27	58 (85)	2	106 (84)	12	79 (83)	41
Gallipolis	1650 (80)	267	208 (82)	54	106 (86)	21	1904 (80)	342	217 (84)	45	94 (85)	57	134 (86)	98	200 (87)	200
Greenup	60 (84)	0	13 (86)	0	70 (86)	0	84 (86)	0	7 (84)	0	3 (86)	0	14 (86)	0	18 (86)	0
Meldahl	2155 (81)	N.A.	416 (82)	N.A.	67 (87)	N.A.	3235 (87)	3235	46 (81)	20	39 (85)	9	34 (87)	34	71 (85)	63
Markland	1199 (85)	47	40 (85)	37	476 (86)	468	1377 (85)	552	30 (85)	26	21 (85)	14	22 (85)	11	70 (85)	50
McAlpine	233 (87)	233	1613 (82)	24	40 (87)	28	1637 (82)	287	47 (86)	39	53 (85)	15	65 (87)	65	119 (87)	119
Cannelton	79 (86)	22	134 (85)	25	3092 (81)	12	3149 (81)	59	34 (86)	21	60 (85)	13	26 (80)	20	73 (85)	54
Newburgh	40 (80)	25	1598 (81)	4	187 (81)	30	1794 (81)	59	26 (80)	22	71 (85)	39	169 (87)	169	230 (85)	230
Uniontown	171 (87)	171	131 (85)	0	489 (80)	7	518 (80)	178	32 (87)	32	70 (85)	3	32 (80)	17	70 (85)	52

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR) *	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION ***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK *	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK *	1987	PEAK *	1987	PEAK *	1987
Allegheny River																
L&D 2	644 (86)	140	18 (82)	0	5 (87)	5	652 (86)	146	5 (87)	5	6 (62)	0	5 (81)	2	11 (82)	7
L&D 3	80 (86)	2	9 (83)	0	7 (87)	7	80 (86)	9	1 (87)	1	3 (83)	0	3 (81)	2	4 (82)	3
L&D 4	226 (84)	0	10 (84)	0	2 (85)	0	237 (84)	0	11 (86)	0	5 (84)	0	2 (85)	0	15 (84)	0
L&D 5	220 (86)	0	99 (87)	99	1 (83)	0	244 (86)	99	2 (86)	0	3 (87)	3	1 (83)	0	3 (87)	3
L&D 6	0	0	3 (83)	N.A.	247 (85)	0	254 (85)	0	0	0	1 (83)	0	9 (85)	N.A.	9 (85)	0
L&D 7	0	0	0	N.A.	0	0	0	0	0	0	0	0	0	N.A.	0	0
L&D 8	0	0	132 (87)	132	504 (85)	11	503 (85)	143	0	0	3 (87)	3	1 (87)	1	4 (87)	4
L&D 9	0	0	0	N.A.	0	N.A.	0	0	0	0	0	N.A.	0	N.A.	0	0
Kanawha River																
Winfield	1164 (82)	159	359 (87)	359	2436 (85)	267	1833 (85)	785	49 (86)	26	62 (82)	56	154 (86)	105	251 (86)	187
Marmet	1405 (87)	94	28 (86)	1	343 (84)	1	907 (81)	96	27 (86)	8	3 (86)	2	23 (84)	8	46 (86)	18
London	761 (83)	214	18 (85)	12	3945 (84)	813	8080 (86)	1039	57 (80)	5	10 (82)	5	334 (87)	334	344 (87)	344
Winfield (u. const.)																
Kentucky River																
L&D 1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Green River																
L&D 1	3 (81)	4	14 (81)	5	3118 (81)	5	3135 (81)	14	6 (81)	2	6 (81)	1	12 (81)	4	22 (81)	7
L&D 2	269 (86)	0	14 (85)	0	8 (81)	0	270 (86)	0	4 (81)	0	2 (85)	0	4 (81)	0	8 (81)	0
Cumberland River																
Barkley	186 (80)	55	55 (86)	4	11 (86)	5	212 (80)	64	37 (85)	33	24 (80)	6	85 (86)	6	45 (86)	41
Cheatham	545 (81)	31	190 (84)	29	56 (84)	13	615 (84)	73	33 (84)	22	13 (87)	13	12 (86)	11	46 (84)	46
Old Hickory	368 (83)	27	78 (84)	7	14 (83)	2	382 (83)	36	31 (86)	6	7 (86)	2	3 (86)	2	39 (86)	10
Cordell Hull	19 (85)	N.A.	21 (84)	N.A	8 (85)	N.A.	30 (85)	N.A.	6 (85)	N.A.	4 (84)	N.A.	3 (85)	N.A.	10 (85)	N.A.
Tennessee/Clinch Rivers																
Kentucky	1461 (80)	124	49 (84)	38	34 (86)	32	1510 (80)	194	161 (80)	80	67 (82)	28	343 (86)	172	280 (87)	280
Pickwick	1134 (87)	1134	82 (84)	69	266 (84)	52	1255 (87)	1255	146 (87)	146	35 (84)	30	79 (84)	38	214 (87)	214
Wilson	837 (83)	24	13 (84)	4	79 (84)	18	847 (83)	46	82 (82)	15	6 (86)	3	13 (84)	8	87 (82)	23
Wheeler	438 (85)	29	10 (86)	1	10 (83)	4	44[illegible] (85)	34	42 (85)	14	10 (82)	2	46 (85)	6	49 (86)	20
Guntersville	1436 (80)	6	69 (86)	16	[illegible]5 (81)	4	1460 (80)	26	20 (81)	9	30 (83)	14	20 (86)	8	51 (86)	31
Nickajack	283 (82)	96	11 (84)	0	8 (86)	4	291 (82)	100	67 (80)	27	5 (81)	1	12 (87)	12	63 (80)	36
Chickamauga	471 (83)	36	126 (84)	9	234 (84)	20	616 (84)	65	42 (81)	16	3 (87)	3	33 (84)	10	58 (84)	29

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Smithland	220 (87)	220	414 (82)	78	847 (80)	30	1245 (80)	328	28 (85)	18	144 (85)	38	318 (80)	81	360 (80)	137
L&D 52	338 (82)	11	3231 (80)	1717	1609 (85)	106	3273 (80)	1834	36 (82)	16	86 (87)	86	83 (87)	83	185 (87)	185
L&D 53																
Olmstead (PED)																
Gallipolis (u. const.)																
Monongahela River																
L&D 2	931 (87)	931	1260 (85)	0	49 (87)	49	1559 (85)	981	16 (85)	8	8 (86)	0	8 (86)	3	28 (85)	12
L&D 3	2020 (80)	50	808 (85)	0	282 (85)	1	2041 (80)	51	13 (80)	2	14 (82)	0	8 (80)	1	21 (80)	3
L&D 4	744 (85)	44	105 (85)	0	442 (85)	7	1339 (85)	55	8 (85)	3	32 (85)	0	43 (85)	3	84 (85)	7
Maxwell	1273 (87)	1273	1588 (85)	0	317 (86)	28	1754 (85)	1301	7 (84)	5	21 (82)	0	7 (86)	4	27 (82)	9
L&D 7	253 (84)	42	1389 (81)	1	52 (82)	6	1397 (81)	48	25 (85)	8	19 (82)	1	22 (82)	8	53 (82)	17
L&D 8	84 (85)	52	1440 (81)	0	112 (83)	7	1449 (81)	60	9 (85)	1	46 (85)	0	16 (80)	3	72 (85)	4
Morgantown	12 (85)	2	805 (80)	0	7 (87)	7	805 (80)	10	5 (85)	2	1 (82)	0	3 (87)	3	5 (87)	5
Hildebrand	1 (85)	0	0	0	10 (85)	0	11 (85)	0	1 (85)	0	1 (85)	0	5 (86)	0	5 (86)	0
Opekiska	0	0	0	0	2 (86)	0	2 (86)	0	0	0	0	0	2 (86)	0	2 (86)	0
Grys Land. (u. const.)																
Pt. Marion (u. const.)																

TABLE A-5-2 (CONTINUED)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK* (PEAK YEAR)	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Watts Bar	512 (85)	6	13 (82)	7	14 (87)	14	519 (85)	27	57 (82)	2	4 (87)	4	69 (81)	21	42 (87)	42
Ft. Loudon	149 (87)	149	28 (84)	8	15 (84)	6	163 (87)	163	38 (87)	38	11 (84)	5	12 (86)	8	49 (87)	49
Melton Hill	85 (85)	0	0	0	0	0	85 (85)	0	23 (85)	0	0	0	1 (80)	0	23 (85)	0

N.A. = Not available
* Peak is the year with the highest value for 1980 through 1987.
** Zero indicates that no data is available.
*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:
Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.
Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood
Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-5-3A

SEGMENT NUMBER 5

OHIO RIVER SYSTEM

1975 - 1986

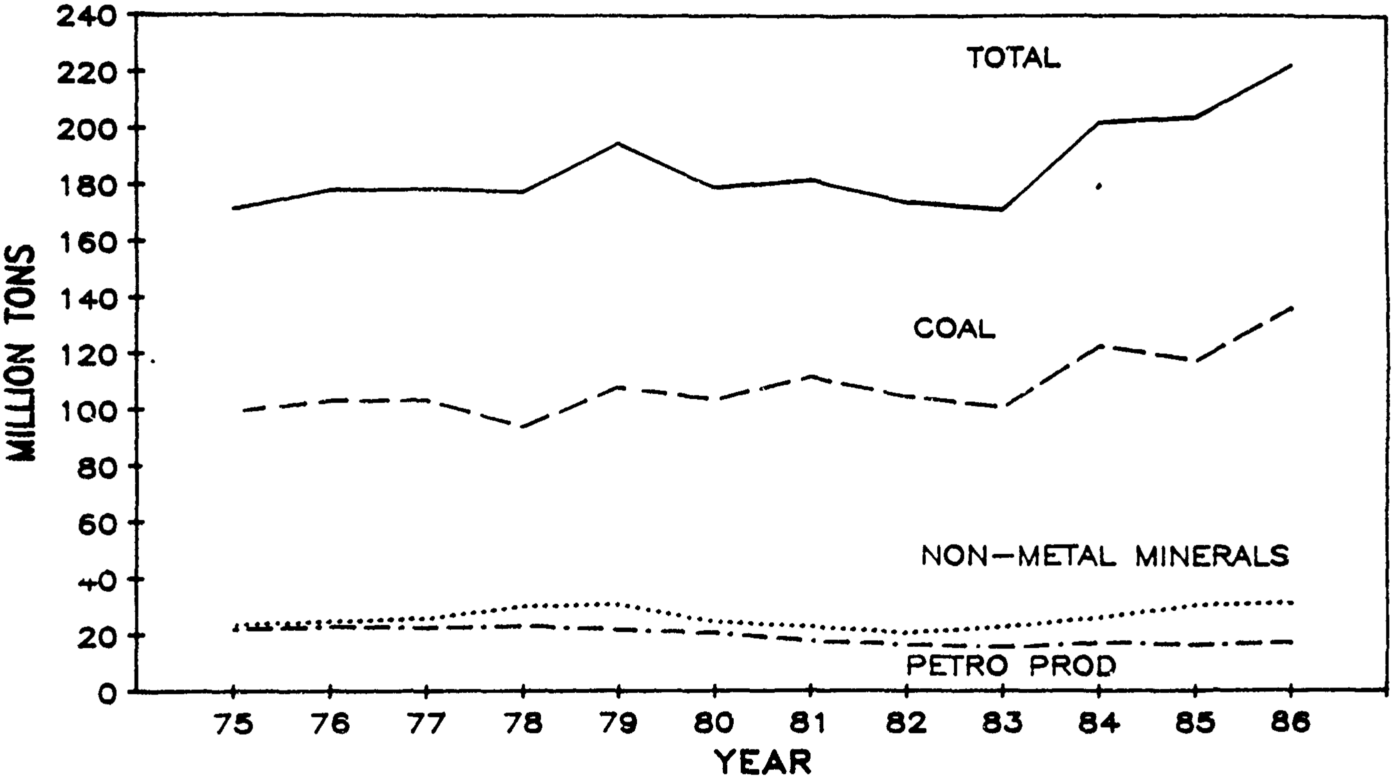
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	4098	5382	5983	6192	7309	6834	7563	12061	10123	9534	12206	10049
Other Agricultural Prdcts	1061	1226	1244	1953	1967	2588	2719	2776	2851	2975	3183	3702
Metallic Ores	1713	1951	1651	2223	2329	1042	1304	764	962	1554	1794	1982
Coal	99313	102990	103287	93954	107962	103782	111571	104599	100679	122530	117316	135870
Crude Petroleum	867	883	406	598	728	562	146	634	856	754	855	565
Non-Metlc Minerals & Prod	23596	24872	26001	30230	30893	24830	22823	20525	22676	26138	30482	31271
Lumber, Wood Prod. & Pulp	504	509	571	742	762	898	963	793	798	747	732	775
Industrial Chemicals	8512	8470	8328	8974	10887	10280	9716	7601	8073	9969	10079	9620
Agricultural Chemicals	874	1053	1399	1360	1484	1512	1389	1704	2792	3316	2826	2833
Petroleum Prdcts	21869	22679	22331	22978	21675	20567	17745	16436	15605	17103	16263	17073
Metallic Products & Scrap	4147	4082	3964	4761	5412	4443	4402	2880	3484	4592	4475	5261
All Other Commodities	4868	3974	3471	3618	3369	1984	1512	3224	2254	3012	3675	3222
TOTAL	171422	178071	178636	177583	194777	179322	181853	173997	171153	202224	203886	222223

PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER, WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

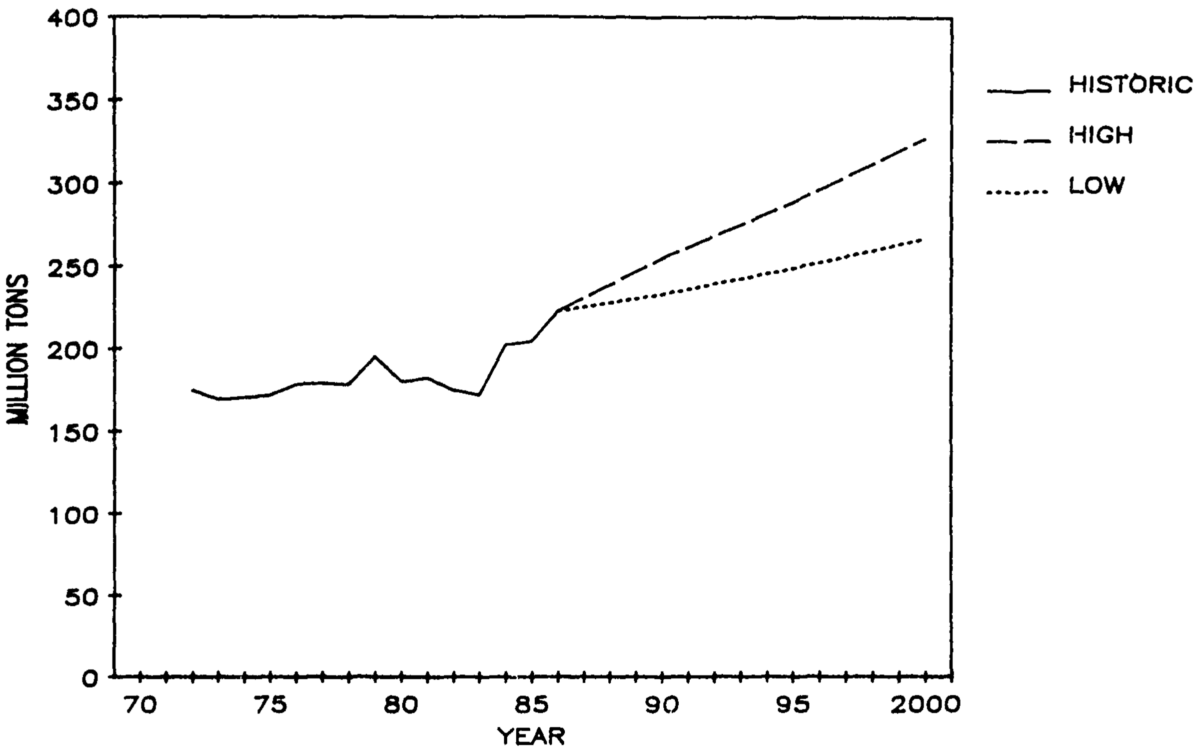
INCLUDES OHIO RIVER-MAIN STEM AND ALL COMMERCIALLY ACTIVE TRIBUTARIES.

FIGURE A-5-2A
SEGMENT NUMBER 5
OHIO RIVER SYSTEM TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-5-3A
SEGMENT NUMBER 5
OHIO RIVER SYSTEM
HISTORIC 1972-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE-A-5-3B
SEGMENT NUMBER 5
OHIO RIVER - MAIN STEM
1975 - 1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	4069	5367	5965	6161	7290	6764	7461	11729	9843	9139	11720	8739
Other Agricultural Prdcts	1059	1226	1243	1949	1965	2585	2701	2745	2808	2951	3151	3643
Subtotal-Farm Prod	5128	6593	7208	8110	9255	9349	10162	14474	12651	12090	14871	12382
Metallic Ores	1702	1912	1641	2220	2293	968	1220	746	933	1480	1728	1845
Coal	72958	78285	81181	73934	83120	85194	94106	86769	84441	100932	96726	114792
Crude Petroleum	867	883	406	598	728	562	146	634	856	754	855	565
Non-Metlc Minerals & Prod	19718	21035	21986	26505	27653	21494	18756	18432	19582	21689	26481	27447
Lumber, Wood Prod. & Pulp	102	47	79	109	142	119	50	57	80	133	143	182
Industrial Chemicals	8228	8066	7917	8570	10444	9937	9410	7358	7887	9765	9873	9458
Agricultural Chemicals	867	1043	1383	1355	1475	1495	1377	1692	2779	3312	2797	2811
Petroleum Prdcts	21731	22531	22187	22796	21451	20362	17576	16259	15485	17030	16147	16916
Metallic Products & Scrap	3877	4034	3933	4744	5389	4438	4409	2875	3438	4572	4382	5207
All Other Commodities	4860	3966	3451	3618	3361	1973	1472	1400	2252	2940	3481	4010
TOTAL	140038	148395	151372	152559	165311	155891	158684	150696	150384	174697	177484	195615

PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER, WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

FIGURE A-5-2B
SEGMENT NUMBER 5
OHIO RIVER - MAIN STEM TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986

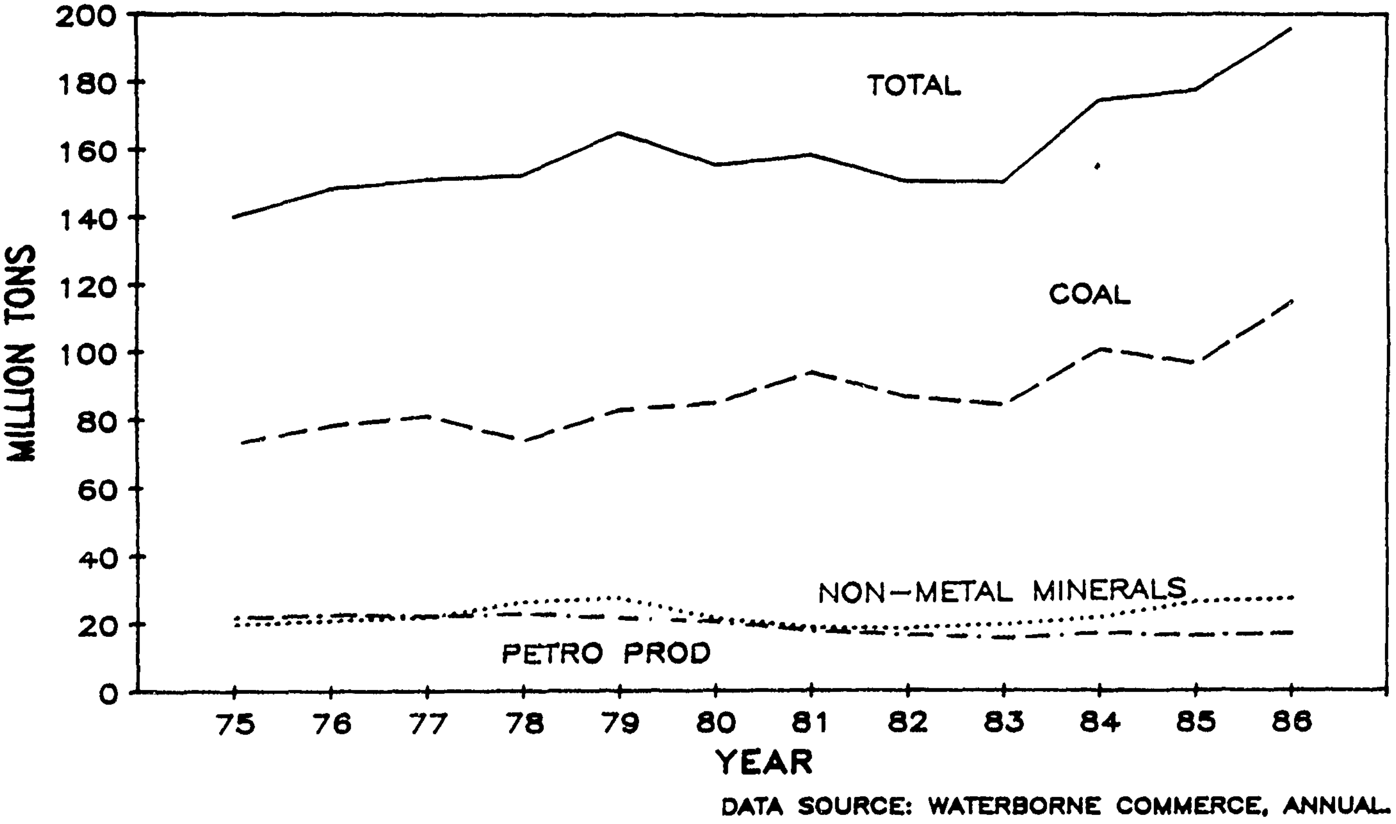
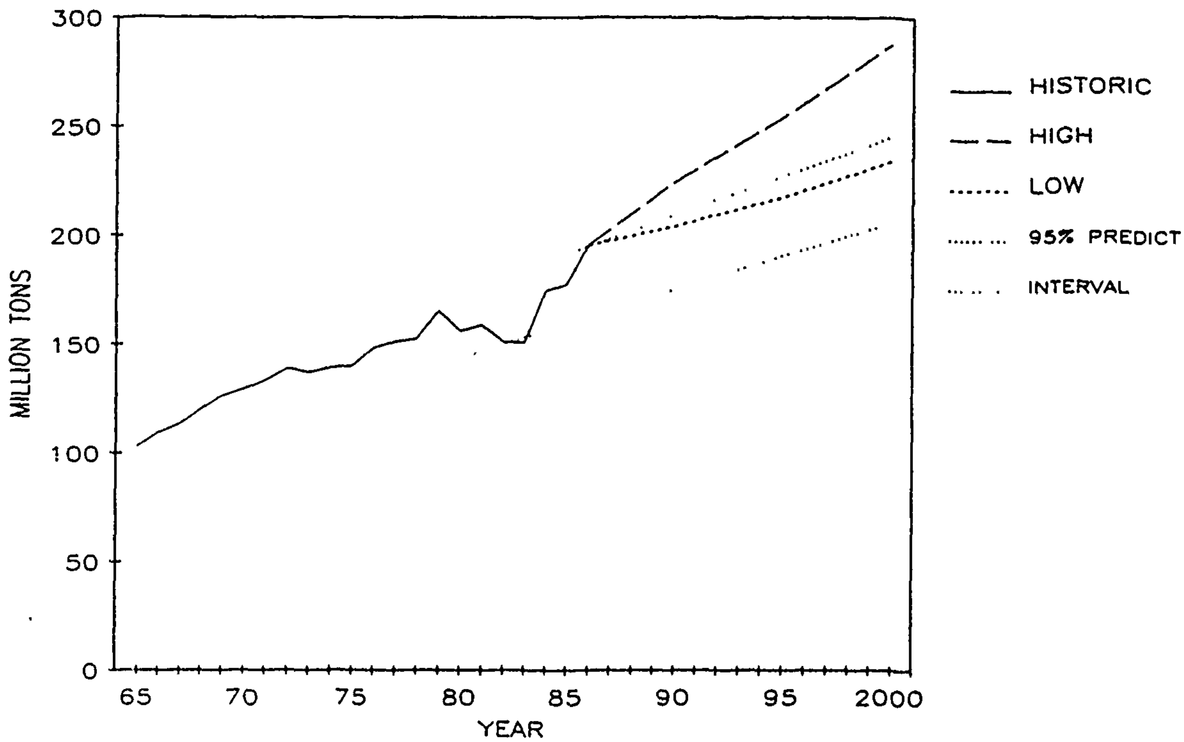


FIGURE A-5-3B
SEGMENT NUMBER 5
OHIO RIVER-MAINSTEM TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



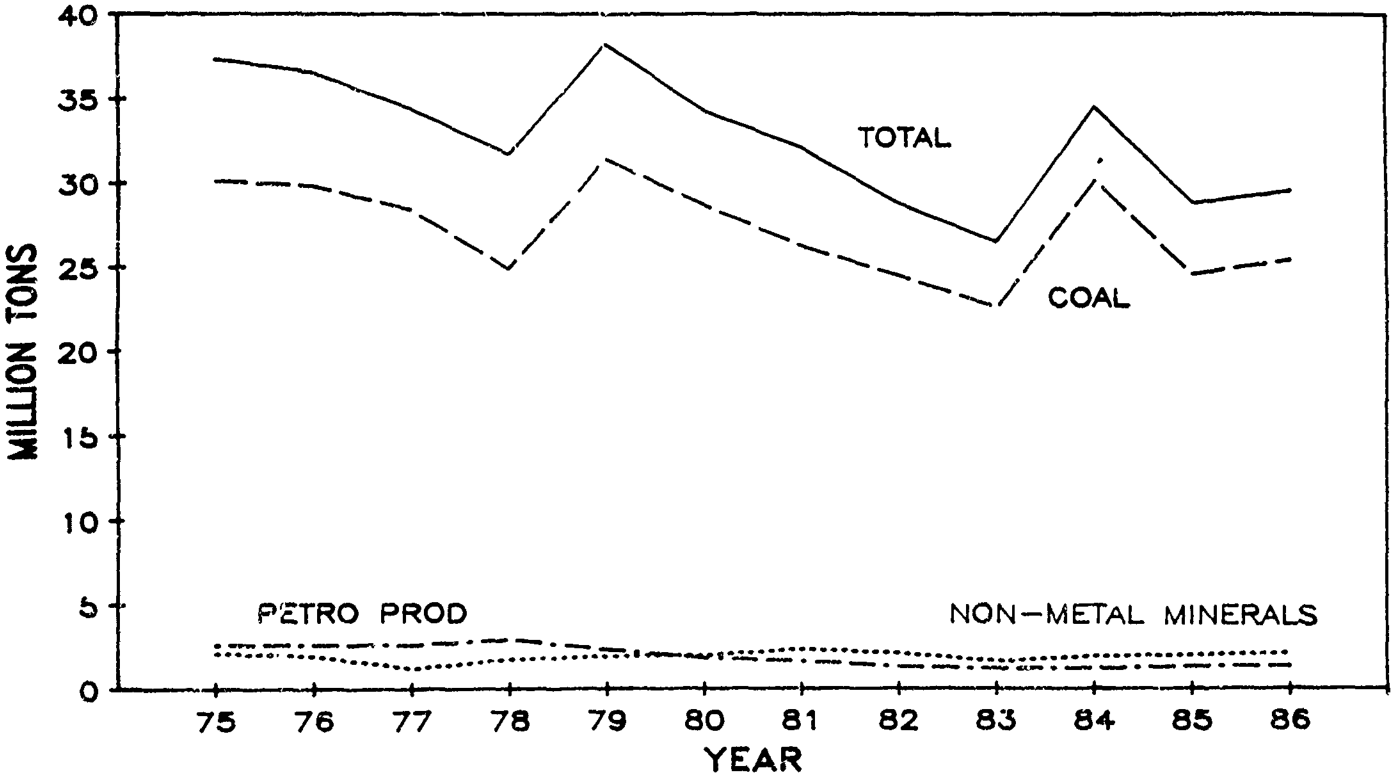
GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-5-3C
SEGMENT NUMBER 5
MONONGAHELA RIVER TRAFFIC
1975 - 1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	0	0	0	0	0	0	0	0	0	0	0	0
Other Agricultural Prdcts	0	0	0	0	0	0	0	0	5	7	5	6
Metallic Ores	524	654	556	556	644	211	273	32	59	97	136	26
Coal	30130	29846	28411	24880	31419	28711	26258	24467	22644	30130	24596	25410
Crude Petroleum	0	0	47	21	1	0	0	7	2	4	0	1
Non-Metlc Minerals & Prod	2121	1923	1174	1687	1912	1978	2256	2125	1644	1947	2001	2132
Lumber, Wood Prod. & Pulp	3	7	4	5	9	5	0	7	21	27	53	56
Industrial Chemicals	480	489	487	463	452	391	393	300	194	283	211	181
Agricultural Chemicals	0	0	0	8	12	19	13	0	10	13	10	21
Petroleum Prdcts	2580	2564	2575	2905	2288	1831	1566	1267	1224	1237	1310	1325
Metallic Products & Scrap	1426	998	1154	1144	1478	1156	1350	610	680	767	437	370
All Other Commodities	4	8	12	5	8	9	8	5	3	2	6	5
TOTAL	37268	36489	34420	31674	38223	34311	32117	28820	26486	34514	28765	29533

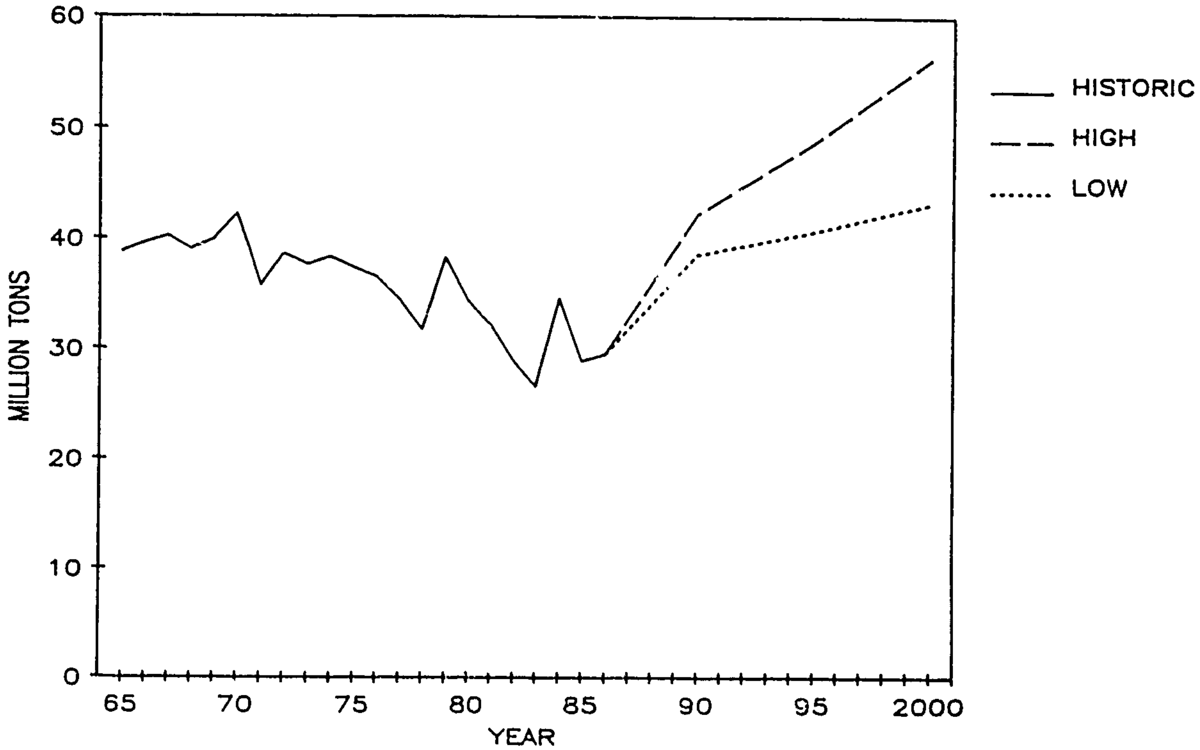
PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER, WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

FIGURE A-5-2C
SEGMENT NUMBER 5
MONONGAHELA RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-5-3C
SEGMENT NUMBER 5
MONONGAHELA RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



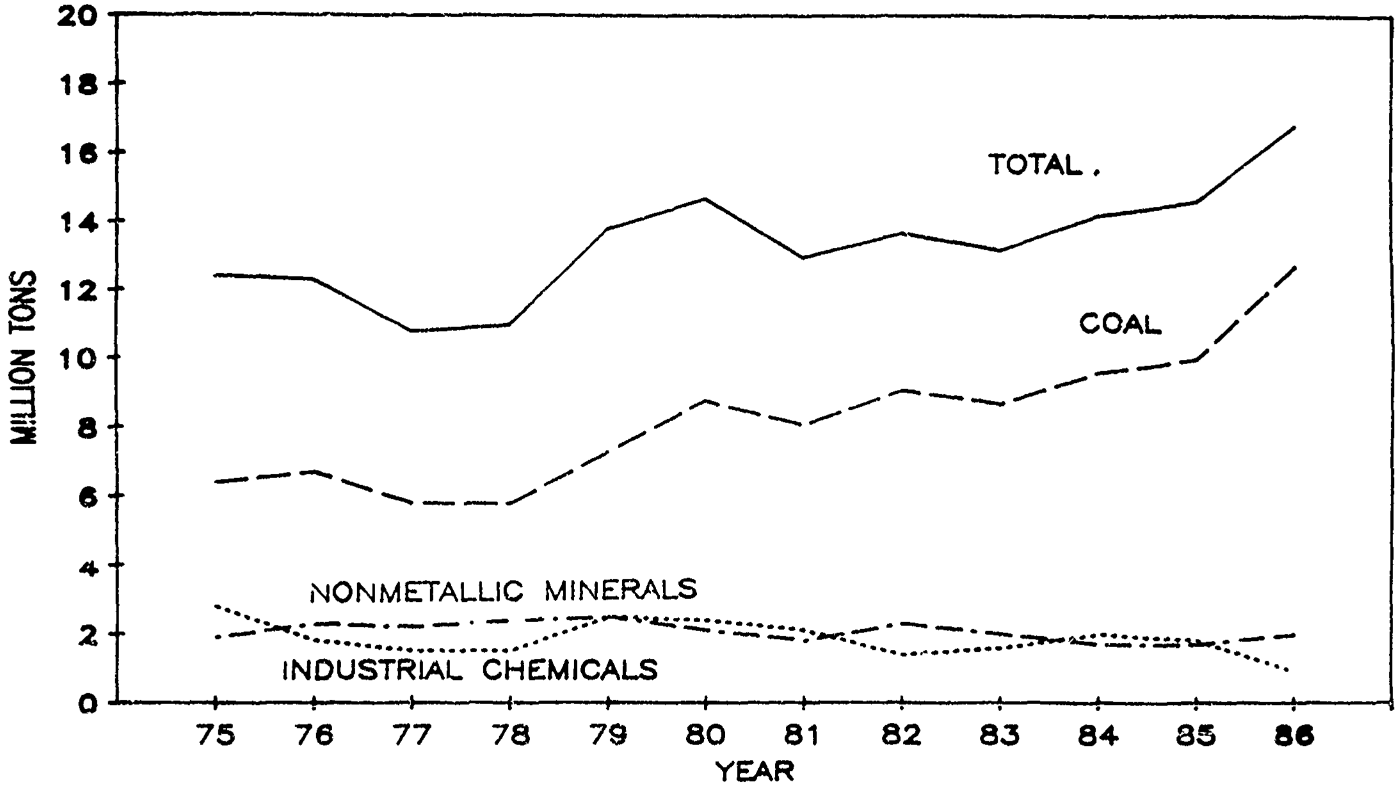
GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-5-3D
SEGMENT NUMBER 5
KANAWHA RIVER TRAFFIC
1975 - 1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	0	0	0	0	1	0	3	0	5	0	0	0
Other Agricultural Prdcts	0	0	0	0	0	0	0	0	0	0	0	0
Metallic Ores	87	51	23	44	56	7	7	0	1	12	7	0
Coal	6435	6672	5841	5802	7323	8753	8143	9135	8681	9570	10048	12729
Crude Petroleum	0	0	0	0	0	0	0	0	18	0	0	0
Non-Metlc Minerals & Prod	1894	2344	2246	2406	2512	2103	1751	2284	1993	1691	1697	2044
Lumber, Wood Prod. & Pulp	0	0	0	0	0	1	0	0	0	0	0	0
Industrial Chemicals	2757	1848	1513	1453	2536	2380	2088	1442	1565	1965	1778	931
Agricultural Chemicals	0	1	0	0	0	0	0	2	2	5	0	14
Petroleum Prdcts	1217	1258	1080	1211	1251	1145	876	784	872	953	1002	1019
Metallic Products & Scrap	40	57	43	67	92	282	120	77	68	33	72	53
All Other Commodities	19	19	10	10	5	3	6	3	0	4	0	0
TOTAL	12449	12250	10756	10993	13776	14674	12994	13727	13205	14233	14604	16790

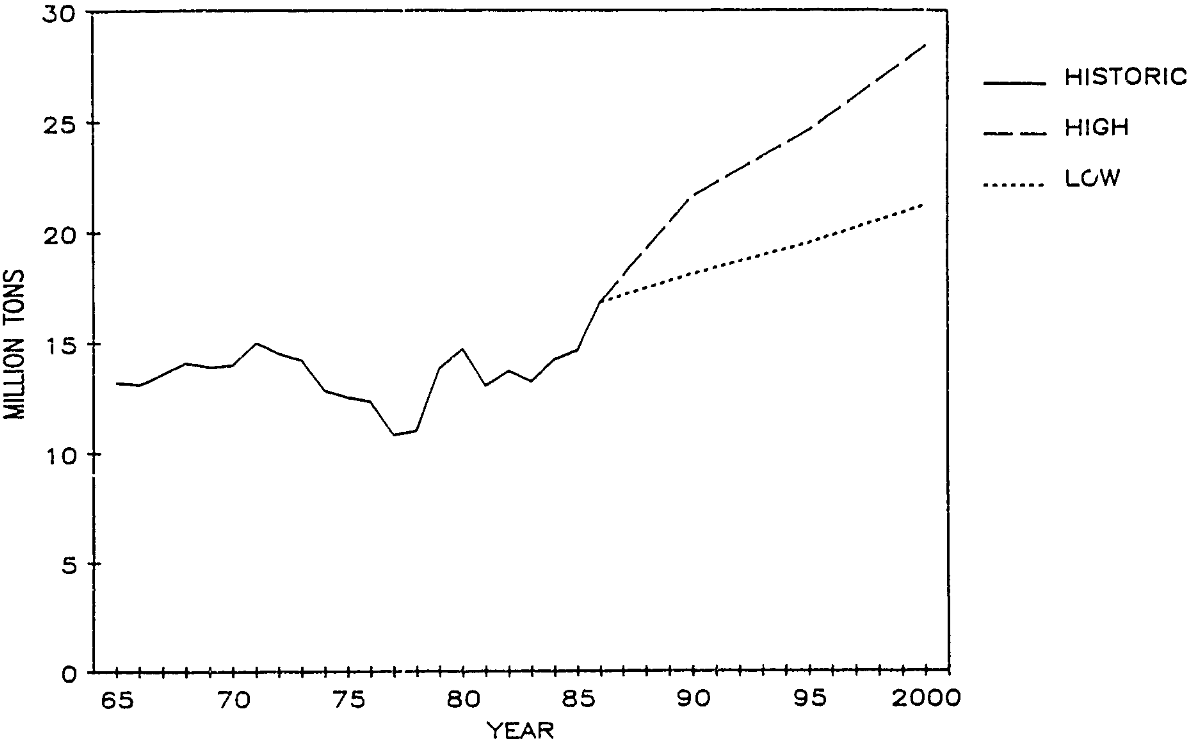
PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER, WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

FIGURE A-5-2D
SEGMENT NUMBER 5
KANAWHA RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL

FIGURE A-5-3D
SEGMENT NUMBER 5
KANAWHA RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



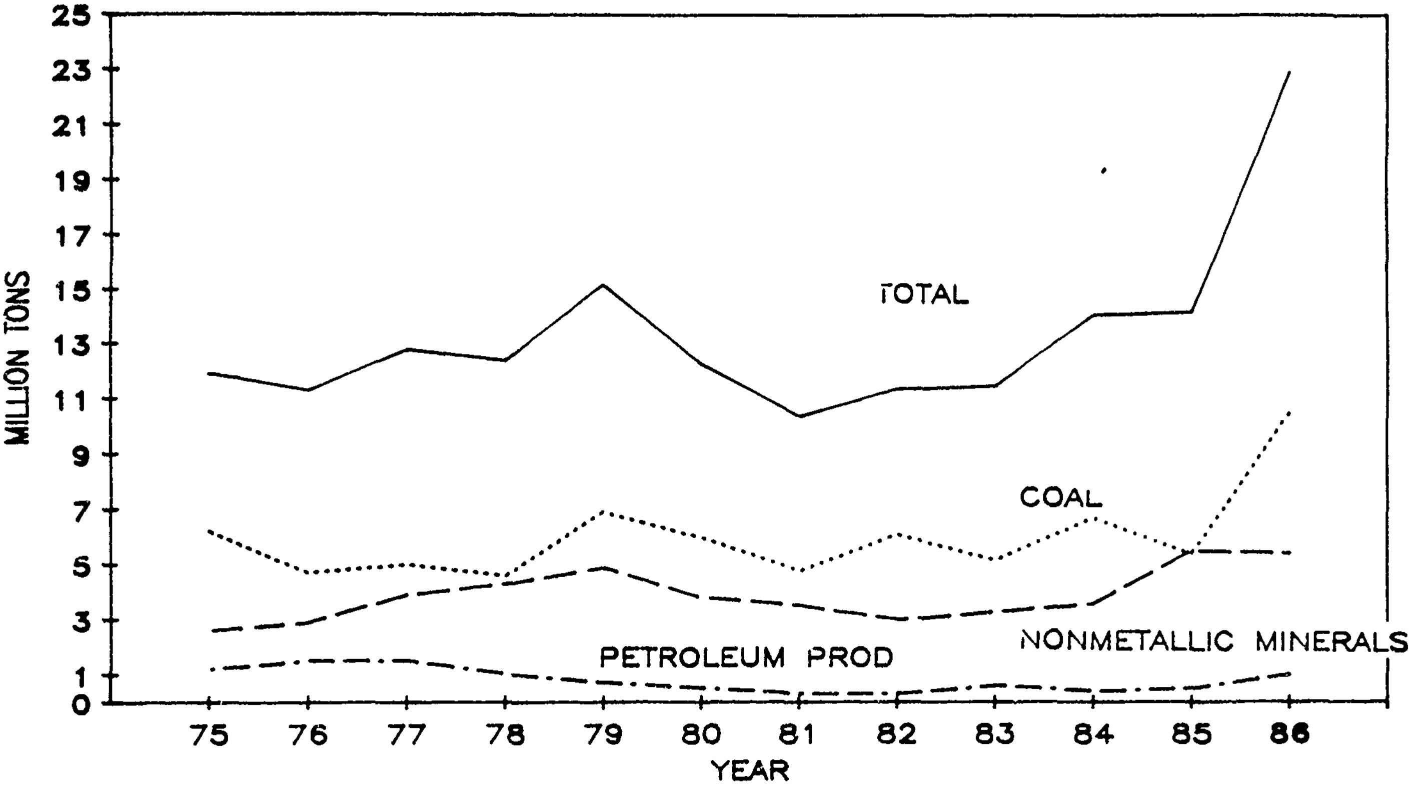
GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-5-3E
SEGMENT NUMBER 5
CUMBERLAND RIVER TRAFFIC
1975 - 1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	5	13	16	23	118	166	185	301	233	175	207	1683
Other Agricultural Prdcts	8	13	18	24	31	9	13	13	13	17	11	285
Metallic Ores	0	0	1	10	28	84	52	23	30	100	92	139
Coal	6195	4658	5003	4598	6854	6043	4786	6119	5188	6654	5354	10587
Crude Petroleum	3	0	0	0	0	5	2	0	0	0	0	3
Non-Metlc Minerals & Prod	2621	2891	3937	4325	4878	3825	3475	3004	3273	3552	5516	5424
Lumber, Wood Prod. & Pulp	1	0	0	4	0	0	0	0	0	0	0	27
Industrial Chemicals	140	196	248	250	317	313	303	215	242	273	228	599
Agricultural Chemicals	22	8	0	4	20	1	1	8	122	226	94	215
Petroleum Prdcts	1238	1540	1491	1049	680	458	284	345	576	442	535	962
Metallic Products & Scrap	202	310	365	439	463	398	365	257	482	588	483	708
All Other Commodities	1425	1690	1682	1671	1774	1047	975	1108	1316	2092	1686	1686
TOTAL	11860	11319	12761	12397	15163	12349	10441	11393	11475	14119	14206	22883

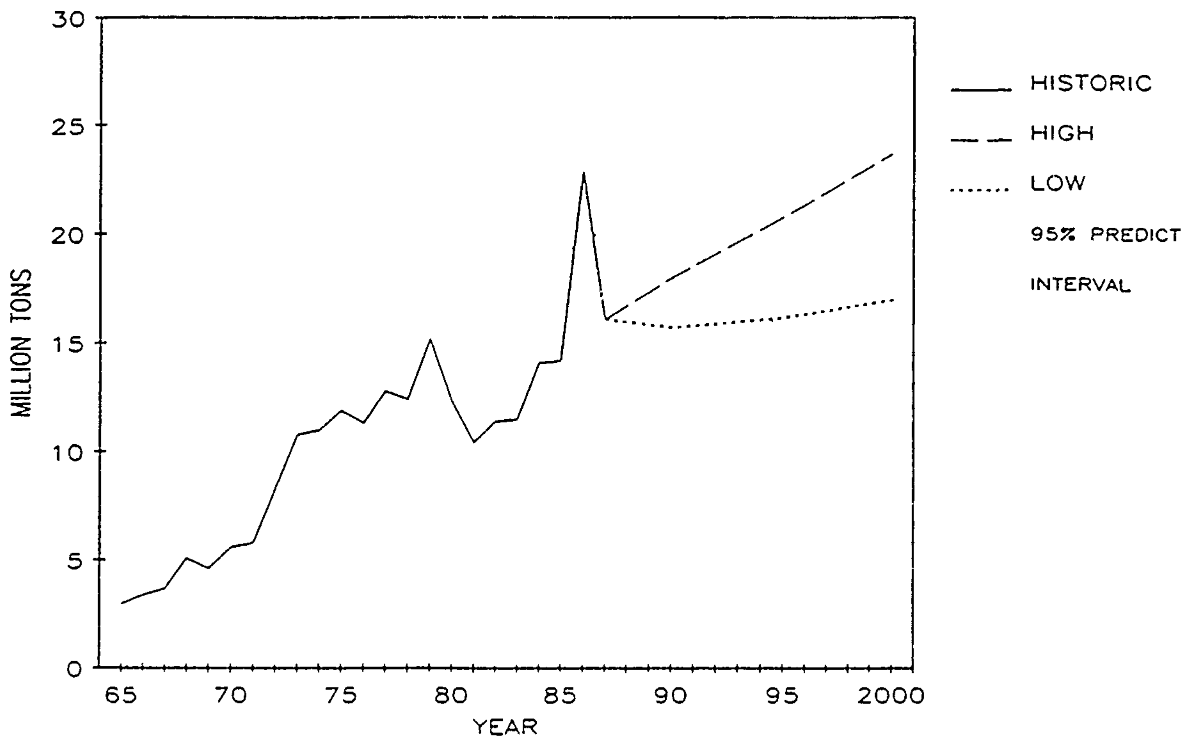
PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER, WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

FIGURE A-5-2E
SEGMENT NUMBER 5
CUMBERLAND RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-5-3E
SEGMENT NUMBER 5
CUMBERLAND RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



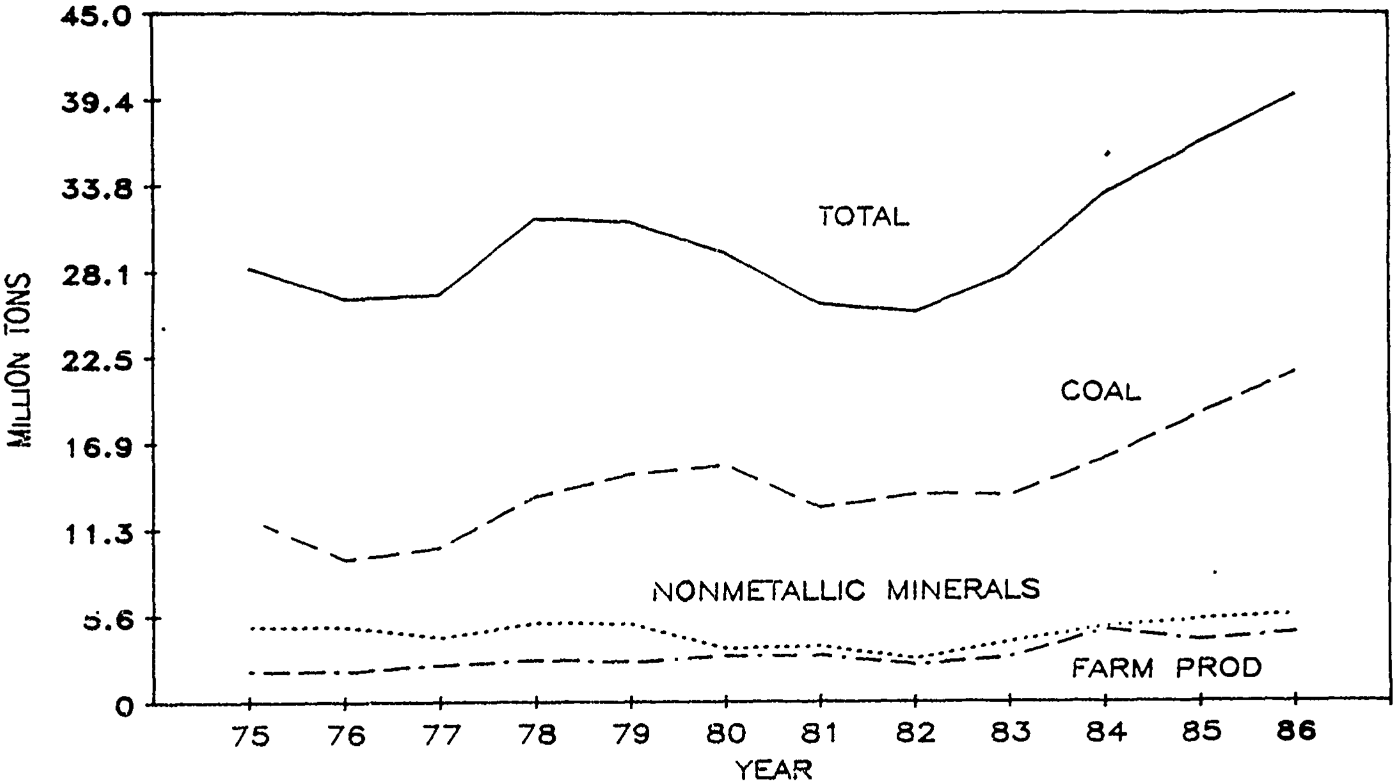
GRAPHED BY IWR. HISTORIC DATA-WCSC (87 DATA EST) PROJECTIONS-VARIOUS

TABLE A-5-3F
SEGMENT NUMBER 5
TENNESSEE RIVER TRAFFIC
1975 - 1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	1347	1415	1680	1991	1940	2296	2477	2841	3176	3935	3285	3614
Other Agricultural Prdcts	604	630	727	758	658	750	519	513	716	767	696	877
Subtotal-Farm Prod	1951	2045	2407	2749	2598	3046	2996	3354	3892	4702	3981	4491
Metallic Ores	252	412	472	649	416	348	348	225	137	459	332	428
Coal	12044	9321	10082	13361	14946	15465	12710	13600	13450	15926	18813	21457
Crude Petroleum	1	3	12	18	40	7	2	3	8	0	0	0
Non-Metlc Minerals & Prod	4867	4901	4220	5217	5102	3458	3555	2835	3876	4931	5378	5727
Lumber, Wood Prod. & Pulp	476	472	523	675	650	813	936	768	759	724	640	666
Industrial Chemicals	1910	2350	2440	2526	2447	2117	1691	1297	1302	1608	1661	1676
Agricultural Chemicals	256	277	292	303	333	372	404	456	616	834	643	539
Petroleum Prdcts	2888	3506	3565	3337	2458	2096	1988	2076	2142	2027	2046	2316
Metallic Products & Scrap	671	912	920	956	919	835	865	647	979	1227	1033	1081
All Other Commodities	2999	2055	1650	1843	1489	840	510	252	827	767	1956	1212
TOTAL	28317	26254	26583	31634	31398	29397	26005	25513	27988	33205	36483	39593

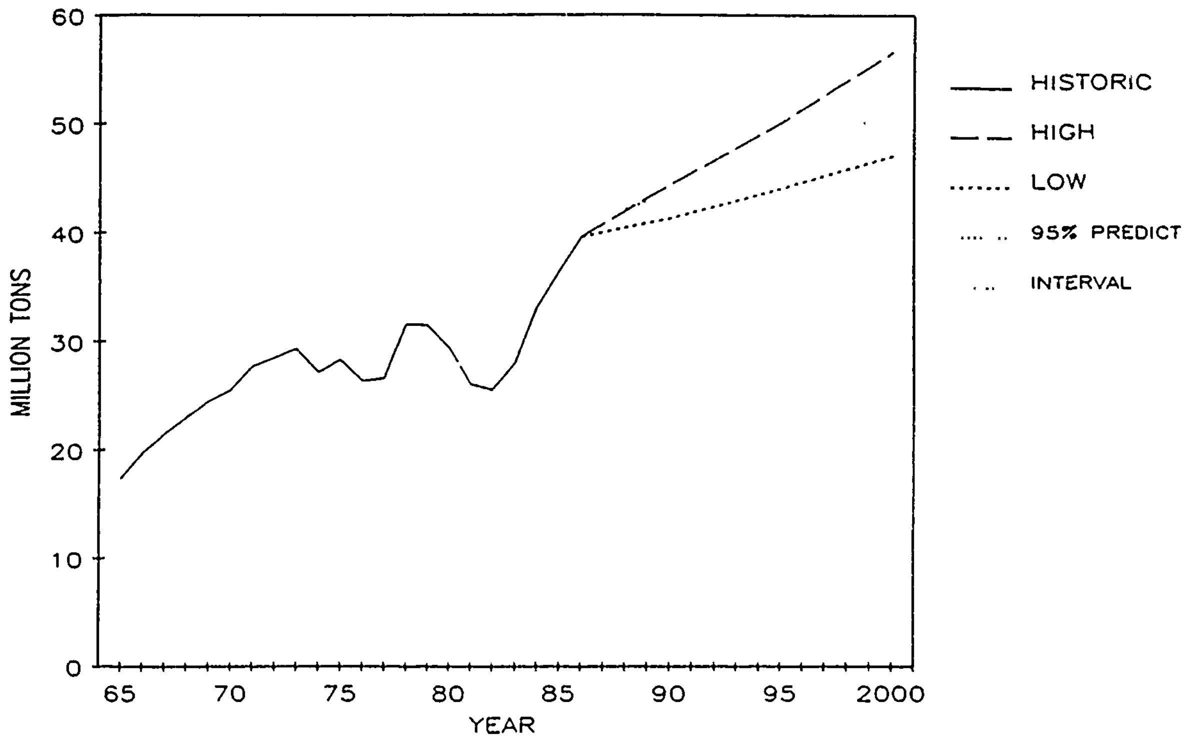
PREPARED BY CEWRC-IWR, JUNE 1987. DATA SOURCE: WATERBORNE COMMERCE STATISTICS CENTER,
WATERBORNE COMMERCE OF THE UNITED STATES," ANNUAL.

FIGURE A-5-2F
SEGMENT NUMBER 5
TENNESSEE RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-5-3F
SEGMENT NUMBER 5
TENNESSEE RIVER TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1930, 1995 AND 2000



GRAPHED BY IWR HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS

TABLE A-5-4
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions) 1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
Ohio River																		
Emsworth	18.2	1.1%	17.2	17.6	20.4	10.6	9.8	5.1	5.2	5.7	2.9	2.8	3.4	3.4	3.6	5	5	5
Dashields	18.6	1.6%	17.9	18.6	21.7	12.0	9.7	4.6	4.6	5.0	2.5	2.5	3.9	4.0	4.4	6	6	7
Montgomery	17.2	2.9%	19.0	20.1	23.0	13.1	9.9	4.2	4.5	4.8	2.4	2.4	4.5	4.4	4.8	6	6	7
New Cumberland	19.0	4.0%	22.8	24.2	28.2	20.7	7.5	3.7	4.0	4.6	2.3	2.3	6.2	6.1	6.1	8	7	8
Pike Island	21.8	4.5%	27.3	29.7	34.0	24.9	9.1	3.7	4.0	4.5	2.2	2.3	7.4	7.3	7.5	9	9	9
Hannibal	24.0	N.A.	29.1	30.3	N.A.	N.A.	N.A.	3.1	3.1	N.A.	N.A.	N.A.	9.3	9.8	N.A.	9	9	N.A.
Willow Island	33.3	-1.5%	30.0	30.0	28.7	18.2	10.5	3.4	3.3	3.2	1.6	1.6	8.9	9.1	9.2	9	9	10
Belleville	34.0	-1.0%	32.4	31.8	30.6	20.4	10.2	3.3	3.1	3.0	1.5	1.5	10.0	10.4	10.1	10	10	11
Racine	35.6	-1.2%	33.2	33.3	31.6	20.7	10.9	3.5	3.5	3.3	1.7	1.6	9.5	9.6	9.6	10	10	11
Gallipolis	41.3	-1.8%	33.3	36.8	34.5	21.3	13.2	3.7	3.8	3.8	1.9	1.9	9.0	9.6	8.9	9	9	10
Greenup	38.4	1.0%	41.1	44.4	42.6	12.9	29.7	4.9	5.3	4.8	2.4	2.4	8.4	8.4	8.8	9	9	10
Meldahl	35.8	1.6%	42.3	46.1	42.1	12.1	30.0	4.3	4.6	4.1	2.1	2.0	9.8	10.0	10.3	10	10	11
Markland	35.7	2.6%	43.4	46.3	46.3	18.2	28.1	4.3	4.7	4.7	2.4	2.3	10.1	9.9	9.8	9	9	10
McAlpine	43.7	2.1%	49.5	53.6	53.9	23.6	30.3	4.9	5.4	5.3	2.6	2.7	10.2	10.0	10.2	9	9	9
Cannelton	44.6	2.3%	51.8	56.8	55.9	24.8	31.1	4.9	5.3	5.2	2.6	2.6	10.7	10.7	10.8	10	10	10
Newburgh	42.9	3.6%	56.5	60.8	61.0	26.7	34.3	6.0	6.5	6.6	3.3	3.3	9.4	9.4	9.3	9	9	10
Uniontown	49.3	3.5%	63.7	68.8	69.7	23.9	45.8	6.3	6.9	6.8	3.4	3.4	10.2	10.0	10.2	10	10	11
Smithland	55.9	3.3%	70.2	75.7	77.6	23.5	54.1	7.2	7.5	7.8	3.9	3.9	9.8	10.0	10.0	10	10	11
L&D 52	52.5	3.4%	79.1	84.3	87.2	33.0	54.2	8.8	9.1	9.7	4.7	5.0	9.0	9.3	9.0	9	10	10
L&D 53	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

TABLE A-5-4 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
Monongahela River																		
L&D 2	15.8	1.1%	15.3	15.9	17.7	5.8	11.9	4.7	4.7	5.1	2.6	2.5	3.3	3.4	3.4	5	5	5
L&D 3	16.6	1.8%	16.4	17.5	19.9	3.2	16.7	6.8	7.1	8.2	4.0	4.2	2.4	2.5	2.4	4	4	4
L&D 4	12.8	3.3%	14.3	16.0	17.7	1.9	15.6	5.0	5.3	5.6	2.8	2.8	2.9	3.1	3.2	5	5	6
Maxwell	12.1	3.0%	13.3	14.7	16.3	1.5	14.8	4.4	4.6	5.0	2.5	2.5	3.0	3.2	3.3	6	5	6
L&D 7	6.2	8.7%	9.8	12.0	14.3	1.4	12.9	4.1	4.5	5.5	2.7	2.8	2.4	2.6	2.6	5	4	5
Pt. Marion	5.2	8.9%	8.4	10.2	12.2	1.4	10.8	3.6	4.0	4.8	2.4	2.4	2.3	2.6	2.5	4	4	4
Morgantown	1.3	9.4%	1.4	1.9	3.2	0.1	3.1	0.0	0.9	1.5	0.8	0.7	2.1	2.1	2.1	4	4	4
Hildebrand	0.4	15.6%	0.8	1.0	1.7	0.0	1.7	0.4	0.4	0.8	0.4	0.4	2.0	2.4	2.3	4	4	4
Opekiska	0.1	21.5%	0.2	0.3	0.7	0.0	0.7	0.2	0.2	0.4	0.2	0.2	1.4	1.6	1.7	3	3	4
Alleghany River																		
L&D 2	2.7	-0.4%	2.3	2.1	1.5	1.8	0.8	1.9	1.7	2.0	1.0	1.0	1.2	1.2	1.2	3	3	3
L&D 3	2.3	1.2%	2.4	2.1	0.7	1.9	0.7	1.9	1.7	2.0	1.0	1.0	1.3	1.2	1.3	3	3	3
L&D 4	1.5	-5.7%	1.9	1.6	N.A.	0.7	0.8	1.8	1.6	1.6	0.8	0.8	1.0	1.0	0.9	3	3	3
L&D 5	1.1	-4.4%	1.1	0.6	N.A.	0.1	0.6	1.3	0.9	0.9	0.4	0.5	0.8	0.7	0.7	4	3	3
L&D 6	0.0	N.A.	1.0	0.1	N.A.	N.A.	N.A.	1.2	0.2	N.A.	N.A.	N.A.	0.8	0.7	N.A.	4	1	N.A.
L&D 7	0.0	N.A.	0.1	0.1	N.A.	N.A.	N.A.	0.1	0.2	N.A.	N.A.	N.A.	0.6	0.7	N.A.	2	1	N.A.
L&D 8	0.0	N.A.	0.6	0.4	17.3	N.A.	N.A.	0.7	0.5	N.A.	N.A.	N.A.	0.8	0.8	N.A.	1	0	N.A.
L&D 9	0.0	N.A.	0.0	0.0	10.1	N.A.	N.A.	0.0	0.0	N.A.	N.A.	N.A.	0.0	0.0	N.A.	0	0	N.A.
Kanawha River																		
Winfield	10.9	4.7%	15.7	17.8	17.3	4.3	13.0	3.9	4.4	4.3	2.1	2.2	4.0	4.0	4.1	5	6	6
Marmet	5.8	5.7%	8.3	10.1	10.1	1.0	9.0	2.9	3.3	3.2	1.6	1.6	2.9	3.1	3.1	4	4	5
London	1.5	10.8%	2.7	3.5	3.9	0.1	3.8	1.3	1.6	1.8	0.9	0.9	2.0	2.1	2.1	2	2	3

TABLE A-5-4 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions) 1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
Kentucky River																		
L&D 1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Green River																		
L&D 1	13.3	-2.7%	10.4	8.6	10.1	1.0	9.1	3.5	2.8	3.5	1.8	1.7	3.0	3.0	2.9	3	3	4
L&D 2	11.5	-5.8%	6.9	5.6	6.3	0.3	6.0	2.4	2.0	2.2	1.1	1.1	2.9	2.8	2.9	3	3	4
Cumberland River																		
Barkley	4.9	0.2%	2.3	12.8	5.0	4.2	0.8	0.6	2.2	1.3	0.5	0.8	3.7	5.8	3.8	7	8	7
Cheatham	4.0	2.1%	4.1	4.4	4.9	4.6	0.3	0.9	1.1	1.1	0.6	0.6	4.4	4.0	4.4	5	5	6
Old Hickory	0.4	7.2%	0.3	0.6	0.8	0.7	0.1	0.2	0.4	0.5	0.3	0.2	1.3	1.6	1.7	1	2	2
Cordell Hull	0.0	N.A.	0.2	0.0	N.A.	N.A.	N.A.	0.1	0.0	N.A.	N.A.	N.A.	1.8	1.4	N.A.	2	1	N.A.
Tennessee River																		
Kentucky	20.0	4.2%	25.6	21.1	30.1	19.9	10.2	3.4	2.7	3.7	1.9	1.8	7.5	7.9	8.2	9	9	10
Pickwick	10.0	5.9%	16.8	19.1	17.8	15.5	2.3	2.2	2.5	2.4	1.1	1.3	7.6	7.5	7.4	9	9	10
Wilson	8.4	-0.9%	7.7	9.0	7.7	5.7	1.9	1.2	1.3	1.2	0.6	0.6	6.8	6.8	6.4	7	8	8

TABLE A-5-4 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
Wheeler	8.2	-1.0%	7.2	8.5	7.4	5.6	1.8	1.0	1.2	1.0	0.5	0.5	6.9	7.2	7.2	8	8	8
Guntersville	5.3	0.7%	6.4	7.2	5.7	3.9	1.8	1.1	1.3	1.0	0.5	0.5	5.9	5.8	5.7	7	7	7
Nickajack	4.7	1.2%	6.0	6.1	5.3	3.2	2.1	1.2	1.3	1.2	0.6	0.6	4.9	4.5	4.7	6	6	6
Chickamauga	1.6	7.5%	1.9	2.1	3.3	1.9	1.4	0.5	0.5	0.7	0.4	0.3	3.7	4.1	4.6	4	5	6
Watts Bar	0.6	12.2%	1.1	1.4	1.9	1.0	0.9	0.3	0.4	0.4	0.2	0.2	3.3	3.6	4.9	3	4	5
Ft. Loudon	0.3	7.2%	0.6	0.5	0.6	0.4	0.2	0.2	0.2	0.3	0.2	0.1	2.3	2.2	2.3	2	2	2
Melton Hill	0.0	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	2	2	1

N.A. = NOT AVAILABLE
SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-5-5

SEGMENT NUMBER 5

OHIO RIVER SYSTEM

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
OHIO										
Ohio R	22,006	22,861	26,736	28,103	27,107	32,790	34,053	36,177	38,446	37,921
Tenn R	3,069	3,971	4,197	4,756	5,277	6,842	7,004	6,978	9,755	16,908
Cumb R	2,653	3,008	3,264	3,007	3,965	4,761	3,659	4,951	9,424	6,713
Green/Brn	1,130	749	779	1,213	1,014	1,163	1,581	1,927	2,155	1,268
Kenty R	4,359	3,087	2,447	2,195	2,641	779	767	1,169	1,610	2,494
Kanawha R	2,595	2,847	3,501	2,576	4,227	4,053	5,188	5,568	7,045	6,838
Alleg R	1,779	1,847	2,915	3,071	3,045	3,088	3,248	3,754	4,030	4,972
Monon R	5,183	5,382	5,495	5,007	6,398	6,014	7,318	8,435	9,676	10,110
Subtotal	42,774	43,752	49,334	49,928	53,674	59,490	62,818	68,959	82,141	87,224

TON MILES OF TRAFFIC (000) CY 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
OHIO										
Ohio R	37,467,432	38,829,638	43,415,919	38,713,852	39,602,080	35,622,263	35,624,055	41,912,942	44,806,898	50,098,862
Tenn R	3,747,589	4,416,600	5,076,227	5,330,100	4,842,190	5,101,877	5,405,255	6,195,802	6,126,969	6,692,208
Cumb R	1,125,393	989,425	1,222,013	1,030,867	934,865	1,013,071	1,070,884	1,115,151	1,247,759	1,732,782
Green/Brn	1,154,760	812,871	856,039	752,428	768,587	764,849	745,771	824,897	783,873	646,639
Kenty R	30,266	25,534	26,883	19,058	14,895	11,269	9,210	12,224	13,001	9,569
Kanawha R	562,178	601,520	783,939	872,623	723,854	845,505	799,671	854,492	900,049	1,060,153
Alleg R	89,243	79,463	89,073	74,904	62,345	66,250	52,412	69,976	73,151	55,842
Monon R	1,351,746	1,223,815	1,590,765	1,507,006	1,431,023	1,491,528	1,228,741	1,575,586	1,280,501	1,307,566
Subtotal	45,528,607	46,978,866	53,060,858	48,300,838	48,379,839	44,916,612	44,935,999	52,561,070	55,232,201	61,603,621

TABLE A-5-5 (continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1986 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	
O & M COSTS PER TON MILE ($) 1977-1986										
OHIO										
Ohio R	0.0006	0.0006	0.0006	0.0007	0.0007	0.0009	0.0010	0.0009	0.0009	0.0008
Tenn R	0.0008	0.0009	0.0008	0.0009	0.0011	0.0013	0.0013	0.0011	0.0016	0.0025
Cumb R	0.0024	0.0030	0.0027	0.0029	0.0042	0.0047	0.0034	0.0044	0.0076	0.0039
Green/Brn	0.0010	0.0009	0.0009	0.0016	0.0013	0.0015	0.0021	0.0023	0.0027	0.0020
Kenty R	0.1440	0.1209	0.0910	0.1152	0.1773	0.0691	0.0833	0.0956	0.1238	0.2606
Kanawha R	0.0046	0.0047	0.0045	0.0030	0.0058	0.0048	0.0065	0.0065	0.0078	0.0065
Alleg R	0.0199	0.0232	0.0327	0.0410	0.0488	0.0466	0.0620	0.0536	0.0551	0.0890
Monon R	0.0038	0.0044	0.0035	0.0033	0.0045	0.0040	0.0060	0.0054	0.0076	0.0077
Segment	0.0009	0.0009	0.0009	0.0010	0.0011	0.0013	0.0014	0.0013	0.0015	0.0014

NOTE: FY 1987 costs in order by the waterway(s) above are 37,718, 13,527, 4,224, 1,207, 1,736, 5,410, 5,898, and 11,803, respectively, and the subtotal is 81,523. 1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-5-6
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
OHIO RIVER								
Emsworth	RC	1982	1986	37,900	0	37,900	100	0
	SCF	1981	1990	5,208 (3)	0	4,173 (3)	80 (3)	635 (3)
	CINA	Unk	Unk	693,000 (3)	346,500 (3)	0 (3)	0	0 (3)
Dashields	RCF	1986	1991	34,000	0	13,321	39	9,100
	SCF	1981	1990	- (3)	0	- (3)	- (3)	- (3)
	CINA	Unk	Unk	- (3)	- (3)	- (3)	0	- (3)
Montgomery	RCF	1985	1988	32,200	0	32,200	100	0
	SCF	1981	1990	- (3)	0	- (3)	- (3)	- (3)
	CINA	Unk	Unk	- (3)	- (3)	- (3)	0	- (3)
Gallipolis	CCF	1985	1991 (2)	336,000	168,000	69,625	20	60,000
McAlpine	SCF	1981	1989	5,815	0	5,090	88	725
	CINA	Unk	Unk	350,000	175,000	0	0	0
Smithland	CCF	1970	1980 (2)	274,100	0	274,100	100	0
L&D 52(Olmsted)	SCF	1986	1992	20,939 (4)	0	5,375 (4)	26 (4)	2,500 (4)
	CINA	Unk	Unk	775,000 (4)	387,500 (4)	0 (4)	0	0 (4)
	RC	1980	1984	8,900	0	9,900	100	0
L&D 53(Olmsted)	SCF	1986	1992	- (4)	0	- (4)	- (4)	- (4)
	CINA	Unk	Unk	- (4)	- (4)	- (4)	0 (4)	- (4)
	RC	1980	1985	4,600	0	4,600	100	0

TABLE A-5-6(continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
MONONGAHELA RIVER								
L&D 2	SCF	1970	1990	3,922 (5)	0	2,922 (5)	75 (5)	600 (5)
	CINA	Unk	Unk	358,000 (5)	179,000 (5)	0 (5)	0 (5)	0 (5)
L&D 3	SCF	1970	1990	- (5)	0	- (5)	- (5)	- (5)
	CINA	Unk	Unk	- (5)	- (5)	- (5)	- (5)	- (5)
	RC	1978	1982	16,000	0	16,000	100	0
L&D 4	SCF	1970	1990	- (5)	0	- (5)	- (5)	- (5)
	CINA	Unk	Unk	- (5)	- (5)	- (5)	- (5)	- (5)
Grays Landing (L&D 7)	CCF	1987	1993 (2)	167,170 (11)	82,500 (11)	9,980	6	14,200
L&D 8 (Point Marion)	CCF	1987	Unk	83,140 (11)	41,450 (11)	2,052	2	2,800
KANAWHA RIVER								
Winfield	CCF	1987	Unk	153,000 (11)	76,500 (11)	3,190	2	6,500
Marmet	SCF	1986	1990	2,375	0	1,725	73	500
	CINA	Unk	Unk	150,000	75,000	0	0	0
London	SCF	1986	1992	1,000	0	150	15	250

TABLE A-5-6(continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
KENTUCKY RIVER								
L&D 1	SCNF	1980	Unk	1,986 (6)	0	1,541 (6)	78 (6)	0 (6)
L&D 2	SCNF	1980	Unk	- (6)	0	- (6)	- (6)	- (6)
L&D 3	SCNF	1980	Unk	- (6)	0	- (6)	- (6)	- (6)
L&D 4	SCNF	1980	Unk	- (6)	0	- (6)	- (6)	- (6)
GREEN - BARREN RIVERS								
L&D 1	SCNF	1961	Unk	2,018 (6)	0	1,119 (6)	55 (6)	0 (6)
L&D 2	SCNF	1961	Unk	- (6)	0	- (6)	- (6)	- (6)
L&D 3	SCNF	1961	Unk	- (6)	0	- (6)	- (6)	- (6)
L&D 4	SCNF	1961	Unk	- (6)	0	- (6)	- (6)	- (6)
L&D 1	SCNF	1961	Unk	- (6)	0	- (6)	- (6)	- (6)
CUMBERLAND RIVER								
Channel Below Barkley	SCF	1975	1988	2,094 (7)	0	2,094 (7)	100 (7)	0 (7)
Celina	CANS	Unk	Unk	39,100 (10)	0	0	0	0
TENNESSEE-CLINCH RIVERS								
Kentucky	SCF	1975	1988	- (7)	0	- (7)	- (7)	- (7)
Wilson	SCF	1975	1993	11,443 (9)	0	6,513 (7)	57 (7)	1,050 (7)
Wheeler	SCF	1975	1993	- (9)	0	- (7)	- (7)	- (7)
Guntersville	SCF	1975	1993	- (9)	0	- (7)	- (7)	- (7)
Nickajack	SCF	1975	1993	- (9)	0	- (7)	- (7)	- (7)
Chickamauga	SCF	1975	1992	4,689 (10)	0	1,809 (7)	39 (7)	800 (7)

TABLE A-5-6(continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
Watts Bar	SCF	1975	1992	- (10)	0	- (7)	- (7)	- (7)
Ft. Loudon	SCF	1975	1992	- (10)	0	- (7)	- (7)	- (7)
BIG SANDY RIVER (NON FUEL TAXED WATERWAY)								
Unk	SC (1)	Unk	1986	165	0	165	100	0
WABASH RIVER (NON FUEL TAXED WATERWAY)								
Unk	SC (1)	Unk	1987	600	0	600	100	0

(1) Unfavorable report.
(2) Year operational.
(3) Total amounts for Emsworth, Dashields, and Montgomery Locks and Dams.
(4) Total amounts for Locks and Dams 52 and 53 (Olmsted).
(5) Total amounts for Locks and Dams 2, 3, and 4.
(6) Total amounts for the waterway.
(7) Total amounts for Cumberland-Tennessee Rivers below Barkley Canal interim study.
(8) Total amounts for Chickamauga, Watts Bar, and Ft. Loudon.
(9) Total amounts for the Channel below Barkley and Kentucky Lock.
(10) Total amounts for Upper Tennessee River Navigation interim study.
(11) 1959 base.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-5-7
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Emsworth	1921	35	48	18.2	17.2	17.6	20.4	-5.0	-0.0	12.1	58.3%	42.5%	63
Dashields	1929	39	54	18.6	17.9	18.6	21.7	-4.0	0.0	16.7	55.6%	40.2%	57
Montogemery	1936	37	39	17.2	19.0	20.1	23.0	10.0	17.0	33.7	62.2%	59.0%	N.A.
New Cumberland	1959	104	125	19.0	22.8	24.2	28.2	20.0	27.0	48.4	27.1%	22.6%	50
Pike island	1968	100	115	21.8	27.3	29.7	34.0	25.0	36.7	56.0	34.0%	29.6%	44
Hannibal	1972	110	132	24.0	29.1	30.3	N.A.	21.0	26.3	N.A.	N.A.	N.A.	33
Willow island	1972	107	130	28.1	30.0	30.0	28.7	7.0	6.8	2.1	26.8%	22.1%	0
Belleville	1968	104	126	28.9	32.4	31.8	30.6	12.0	10.0	5.9	29.4%	24.3%	19
Racine	1971	107	138	30.5	33.2	33.3	31.6	9.0	9.2	3.6	29.5%	22.9%	17
Gallipolis	1937	45	55	37.2	33.3	36.7	34.5	-10.0	-1.3	-7.3	76.7%	62.7%	43
Gallipolis(const)				N.A.	N.A.	N.A.	42.6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Greenup	1959	100	129	35.6	41.1	44.4	42.1	15.0	24.7	18.3	42.1%	32.6%	25
Meldahl	1962	97	133	31.2	42.3	46.1	46.3	35.0	47.8	48.4	47.7%	34.8%	45
Markland	1963	89	133	35.7	43.4	46.3	53.9	21.0	29.7	51.0	60.6%	40.5%	21
McAlpine	1961	82	116	43.7	49.5	53.6	55.9	13.0	22.7	27.9	68.2%	48.2%	65
Cannelton	1972	107	157	44.6	51.8	56.8	61.0	16.0	27.4	36.8	57.0%	38.9%	32
Newburgh	1975	104	128	42.9	56.5	60.8	69.7	32.0	41.7	62.5	67.0%	54.5%	36
Uniontown	1975	114	127	49.3	63.9	68.8	77.6	30.0	39.6	57.4	68.1%	61.1%	34
Smithland	1980	177	214	55.9	70.2	75.7	87.2	26.0	35.4	56.0	49.3%	40.7%	37
Lock 52 (locks only)	1928	100	115	62.5	79.3	84.3	N.A.	27.0	34.9	N.A.	N.A.	N.A.	59
Lock 53 (locks only)	1929	100	115	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Olmstead					N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2	1951	50	74	15.8	15.3	15.9	17.7	-3.0	0.0	12.0	35.4%	23.9%	53
L&D 3	1907	37	57	16.6	16.4	17.5	19.9	-1.0	0.5	19.9	53.8%	34.9%	59

TABLE A-5-7 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
L&D 4	1932	37	62	12.8	14.3	16.0	17.7	12.0	25.0	38.3	47.8%	28.5%	55
Maxwell	1964	59	95	12.1	13.3	14.7	16.3	10.0	21.5	34.7	27.6%	17.2%	53
L&D 7	1925	17	20	6.2	9.8	12.0	14.3	57.0	93.5	130.6	84.1%	71.5%	59
Grays Lndng(const)				N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Pt. Marion	1925	17	20	5.2	8.4	10.2	12.2	61.0	112.5	134.6	71.8%	61.0%	48
Morgantown	1950		25	1.3	1.4	1.9	3.2	0.7	46.1	146.2	N.A.	12.8%	10
Hildebrand	1959		25	0.4	0.8	1.0	1.7	100.0	150.0	325.0	N.A.	6.8%	5
Opekiska	1964		11	0.1	0.2	0.3	0.7	100.0	200.0	600.0	N.A.	6.4%	4
L&D 2	1934	15	16	2.7	2.3	2.1	2.6	-15.0	-22.2	-3.7	17.3%	16.3%	26
L&D 3	1934	15	16	2.3	2.4	2.1	2.6	0.4	-8.7	13.0	17.3%	16.3%	23
L&D 4	1927	16	17	1.5	1.9	1.6	1.5	-27.0	-6.6	0.0	9.4%	8.8%	17
L&D 5	1927		16	1.1	1.1	0.6	0.7	0.0	-45.4	-36.4	N.A.	4.4%	8
L&D 6	1928		16	0.0	1.0	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4
L&D 7	1930		16	0.0	0.1	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5
L&D 8	1931		16	0.0	0.6	0.4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3
L&D 9	1938		16	0.0	0.0	0.0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3
Winfield	1937	18	22	8.1	15.6	17.7	17.3	93.0	118.5	113.6	96.1%	78.6%	
Winfield(const)				N.A.	N.A.	N.A.		N.A.	N.A.	N.A.	N.A.	N.A.	81
Marmet	1934	18	22	5.2	8.3	10.1	10.1	58.0	94.2	94.2	56.1%	45.9%	48
London	1934	18	22	1.4	2.7	3.5	3.9	87.0	150.0	178.6	21.7%	17.7%	21
L&D 1	1839		6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 2	1839		6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

TABLE A-5-7 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR CPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
L&D 3	1844		6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 4	1844		6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
L&D 1	1956		46	13.3	10.4	8.6	10.1	-22.0	-35.3	-24.1	N.A.	N.A.	N.A.
L&D 2	1956		46	11.5	6.9	5.6	6.3	-40.0	-51.3	-45.2	N.A.	22.0%	14
L&D 3	1836		NC	N.A.	N.A.	N.A.		N.A.	N.A.	N.A.	N.A.	13.7%	13
Barkley	1964	30	34	4.9	2.3	12.8	5	-53.0	161.2	2.0	16.7%	14.7%	21
Cheatham	1964	35	39	3.7	4.1	4.4	4.9	10.0	18.9	32.4	14.0%	12.6%	12
Old hickory	1954	7	9	0.4	0.3	0.6	0.8	-14.0	50.0	100.0	11.4%	8.9%	18
Cordell hull	1973	7	9	0.0	0.2	0.0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Kentucky	1944	35	39	18.5	25.6	21.1	30.1	33.0	14.1	62.7	86.0%	77.2%	86
Pickwick	1937	75	80	8.3	16.8	19.1	17.8	103.0	130.1	114.5	23.7%	22.3%	50
Wilson	1959	36	42	7.0	7.7	9.0	7.7	10.0	28.6	10.0	21.4%	18.3%	37
	1927												
Wheeler	1963	46	55	6.8	7.2	8.5	7.4	5.8	25.0	8.8	16.1%	13.5%	22
	1934												
Guntersville	1965	40	45	4.0	6.4	7.2	5.7	60.0	80.0	42.5	14.3%	12.7%	32
Nickajack	1967	25	29	3.5	6.0	6.1	5.3	71.4	74.3	51.4	21.2%	18.3%	21

TABLE A-5-7 (Continued)
SEGMENT NUMBER 5
OHIO RIVER SYSTEM

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Chickamauga	1939	5	7	1.4	1.8	2.1	3.3	28.6	50.0	135.7	66.0%	47.1%	52
Watts bar	1941	5	7	0.4	1.1	1.4	1.9	175.0	250.0	375.0	38.0%	27.1%	29
Ft. Loudon	1943	5	7	0.2	0.6	0.5	0.6	200.0	150.0	200.0	12.0%	8.6%	17
Melton hill	1963	5	7	0.0	0.0	0.0	0.0	0.0	N.A.	0.0	0.0%	0.0%	39

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-6-1). This segment consists of the Gulf Intracoastal Waterway (GIWW) from Apalachee Bay near St. Marks, Florida, to the Mexican border at Brownsville, Texas 1,113 miles, including the GIWW alternate route from Morgan City to Port Allen, Louisiana (64 miles); the Apalachicola, Chattahoochee, and Flint Rivers (297 miles); and the Pearl River (58 miles). The main channel project depth for the GIWW and the alternate route is 12 feet deep and 125 feet wide, except for 150 feet wide between the Mississippi River and Mobile Bay portion of the GIWW-East. The portion of the GIWW from Carabelle, about 20 miles west of Apalachee Bay, to St. Marks, at the head of the bay, has not been constructed. That requires use of an open water route on the Gulf of Mexico and Apalachee Bay. The A-C-F is nine feet deep and 100 feet wide and the Pearl River is 7 feet deep and 100 feet wide. During dry periods the nine-foot depth on the A-C-F is not always available. There are about fifteen GIWW side channels and tributaries ranging from two to 35 miles long and the usual dimensions are 12 feet deep and 125 feet wide or 9 by 100 feet. The GIWW connects with nine non fuel taxed waterways and 23 harbors along the Gulf Coast with over 250,000 tons of traffic. The Okeechokee Waterway connects the Atlantic and Gulf sections of the intracoastal waterway by traversing the southern part of the Florida peninsula via Lake Okeechokee. It has a 155 mile channel that is mostly eight feet deep and 80 to 100 feet wide between Stuart, about 240 miles south of Jacksonville on the Atlantic side, and Fort Myers, about 100 miles south of Tampa Bay on the Gulf side. The Intracoastal Waterway from the Chattachoochee River (Okeechokee Waterway) to the Anclote River provides a 160 mile long channel nine feet deep and 100 feet wide from Fort Myers generally along inside protected waters north to Japan Springs, about 60 miles north of Tampa Bay. Neither this IWW nor the Okeechokee waterway is the fuel taxed waterway.

b. Locks (Table A-6-1). There are locks on all three waterways with the GIWW having ten and two floodgates, the A-C-F having three locks and dams, and the Pearl River having three locks. On the GIWW lock sizes include 425, 640, 747, and 760, and about 1200 (five locks) foot lengths and 75 foot widths except for 56, 84, and 110 feet at three locks. Lifts range from 5 to 45 feet with greater lift found at locks close to the Mississippi River. Inner Harbor Lock is 65 years old and Harvey Lock is 54 years old, but the other eight locks and two floodgates are 3 to 37 years old. On the A-C-F the three locks are 450 feet long and 82 feet wide. Their lift is about 30 feet at two locks, but 88 feet at the third. The Pearl River locks are 310 by 65 feet and have lifts of 11 to 27 feet. The locks on the A-C-F are 25-34 years old while the Pearl River locks are 37 years old. There are five locks and dams on the Okeechokee waterway that are 50 or 56 feet wide, 250 or 400 feet long, and 13 to 51 years old. No data on the locks is provided in the following tables since the locks are not on a fuel taxed waterway.

2. PERFORMANCE CHARACTERISTICS (Table A-6-2).

The total average processing time ranged from 41 minutes to 592 minutes (9.87 hours). For the locks for which data was available, the median value is 94.5 minutes. Total peak average processing time for the 1980-1987 time

period ranged from 26 minutes (1986) at Brazos River East Gate to 1010 minutes or 16.83 hours (1980) at Calcasieu Lock. In this segment, the highest total peak average processing time from 1980 to 1987, occurred at Calcasieu Lock in 1980 (1010 minutes). Total delay in 1987, ranged from 3841 hours to 106,551 hours. For locks which had data available, total delay had a median value of 9399.5 hours, and four locks (Harvey Lock, Bayou Boeuf, Port Allen, and Bayou Sorrell) fell below this value. The peak total delay for the 1980-1987 time period varied from 18 hours (1983) at Walter F. George to 180,279 hours (1980) at Inner Harbor. From 1980 through 1987, Inner Harbor had the highest peak total delay of 180,279 hours in 1980. Lock utilization for 1987 ranged from 41% to 100%. For the locks for which data was available, the median lock utilization value for 1987 was 68%. The peak lock utilization data from 1980 to 1987 ranged from 21% (1986) at Colorado River West Lock to 100% (1987) at Inner Harbor. In this segment, the highest peak utilization rate for the 1980-1987 time period occurred in 1987, for Inner Harbor (100%). Total downtime for 1987, ranged from 5 hours to 1616 hours. For the locks for which data was available, the 1987 median value was 239 hours and Inner Harbor and Port Allen had total downtime hours considerably above the median. The total peak downtime varied from 0 hours at Brazos River East Gate and Colorado River East Lock to 3755 hours (1981) at Harvey Lock. The highest total peak downtime, during the 1980-1987 time period, occurred in 1981, at Harvey Lock (3755 hours). Total stall events for 1987 ranged from 3 to 285. For the locks where data was available, the median value of 63 stall events and Harvey Lock was the only lock that had stall events far in excess of the system median. The total peak stall events, from 1980 through 1987, ranged from 0 at Brazos River East Gate and Colorado River East Lock to 610 at Inner Harbor in 1984. In this waterway, for the 1980-1987 time period, the highest total peak stall events occurred at Inner Harbor in 1984 (610 stall events).

3. COMMODITY TRAFFIC (Tables A-2, A-6-3A,-4); (Figures A-6-2,-3).

a. Historical. Traffic on the Gulf Intracoastal Waterway, which had declined from a peak of 109 million tons in 1972 to a low of less than 82 million tons during the 1982 recession, recovered to 106 million tons in 1986. The importance of this waterway to the petrochemical industries of the Texas and Louisiana coasts can be seen in the mix of traffic utilizing it. Unlike most of the inland waterways, traffic in crude petroleum and petroleum products has been increasing recently, on the GIWW. Petroleum products, particularly gasoline and distillate and residual fuels, reached a peak in 1986 of 36.7 million tons (over 35 percent of total GIWW traffic), up from 27 million in 1975. Crude petroleum, which had declined from 24.7 million tons in 1977 to 15.2 million in 1981, recovered steadily to 20.7 million tons in 1986. Industrial chemicals, which had declined from over 15 million tons in 1979 to less than 12.5 million during the 1982 recession, rebounded to a peak in 1986 of nearly 17.1 million tons. Other important commodities include non-metallic minerals and products, coal, and metallic products and scrap. Coal has increased significantly from a 1983 low of 3.9 million tons to nearly 8.8 million in 1986.

b. Forecast. Total tons on the GIWW are projected to decline slightly under low scenario assumptions to 101.7 million tons due to lower petroleum movements by 2000. Under the high scenario crude movements decline less and products and coal increase moderately, pushing total tonnage up to 131.0

million by 2000 (see Figure A-6-3). These projections are adjusted to account for historic traffic fluctuations on the GIWW. Petroleum products shipments accounted for 35 percent of all tons in 1986 and make up the major commodity group influencing future traffic forecasts. Lower petroleum prices are primarily responsible for the recent surge in demand for petroleum products, especially residual fuel oil. Continued demand for residual oil by electric utilities, as well as increasing demand for gasoline, diesel, and jet fuel by the transportation sector, should stimulate slow but steady growth in petroleum products traffic. Crude petroleum movements on the GIWW (20 percent of the total traffic in 1986) are projected to decline under all scenarios at varying rates, thereby dampening total traffic forecasts. In contrast, industrial chemical shipments (16 percent of 1986 traffic) should grow significantly and provide a positive stimulus to total GIWW traffic.

c. Tonnages at Locks. Based on average annual percent change during 1977-1987 at all locks for which data were available, changes ranged from -7.5 percent (Harvey Lock) to 3.1 percent (Port Allen) per annum. For 1987, actual tonnage changes from 1977 ranged from a decrease of 4.2 million tons at Harvey to an increase of 5.0 million tons at Port Allen (actually more than 5.0 million tons because the 1987 Port Allen data excluded September and October).

4. OPERATION AND MAINTENANCE COSTS (Table A-6-5).

O&M costs in actual dollars increased from about $23 million in 1977 to about $38 million in 1986, or about a 3% decline in real terms when adjusted for about 68% inflation during the same period. Traffic decreased from about 20 billion ton-miles in 1977 to about 19 billion ton-miles in 1986. O&M costs per ton-mile increased from 1.1 mills in 1977 to 2.0 mills in 1986. The ton-mile cost on this segment ranked the fifth lowest of all nine segments.

5. PROGRAM STATUS (Table A-6-6).

a. Overview. There are five projects authorized for construction, of which one is proceeding, two are in preconstruction studies, and two are deferred due to unfavorable studies. There are one navigation study and four basin studies, of which two concern non-fuel-taxed waterways.

b. GIWW.

(1) The Inner Harbor Navigation Canal (IHNC) Lock, part of the Mississippi River - Gulf Outlet project, was authorized in 1986 for construction of a replacement shiplock at that site or at the Violet site in St. Bernard Parish with dimensions of 1,200 feet long, 110 feet wide, and 40 feet deep. The shiplock portion of the MRGO project, with an estimated cost of $685.5 million, is 18 percent complete this year and with funds requested for FY 1989. An updated reanalysis study began in 1986 and is expected to be completed in 1990. Until the study is completed, the cost estimates for construction of the shiplock and user fund and non-federal shares are tentative. In 1987 the St. Bernard Parish Police Jury voted against siting the new lock in St. Bernard Parish. If economically justified and if a positive recommendation is made, then construction could begin in the mid-1990's. Completion of the shiplock is indefinite pending a decision to initiate construction.

(2) The $4.4 million study of the Louisiana - Texas section is determining if the existing project should be modified, particulary with regard to widening and deepening the channels. It is 85 percent complete this year and will be 89 percent complete with funds requested for FY 1989. It is scheduled for completion 1990. Work in 1988 includes continuation of preliminary engineering and design, continuation and completion of economic studies, environmental analyses, and cost estimates, and beginning preparation of the draft report and EIS.

(3) The study of the Channel to Victoria for 35 miles via the Guadalupe River was completed in 1985 and recommended enlargement of the channel from 9 foot deep and 100 foot wide to the standard GIWW dimensions of 12 by 125 feet. Construction of the $23.9 million project may be authorized in 1988. Preconstruction engineering and design costing $0.7 million is scheduled for initiation in FY 1989 and completion 1991. Although a part of the fuel taxed inland waterways system, the project is being considered as a channel for a harbor of 20 foot depth or less for cost sharing purposes. Therefore no money for the project would be drawn from the Inland Waterways Trust Fund.

(4) The authorized completion of the GIWW from Carrabelle to St. Marks, Florida, was deferred for restudy some years ago. A restudy completed in 1969 determined that the most feasible route from a navigation and economic standpoint would have an adverse environmental effect. The unfavorable report caused the project to be classified as deferred for restudy.

c. Apalachicola, Chattahoochee, and Flint Rivers. The basin is being studied for development of water management plans for the system that will consider water-related needs of all users. The $2.3 million study, which will feature a navigation maintenance plan, is scheduled for completion in December 1988.

d. Pearl River.

(1) The Pearl River has been removed from caretaker status and will be open to navigation in FY 1989. Local interests requested that maintenance of the West Pearl River channel and operation of the three locks be resumed due to the prospects for a resumption of traffic from Bogalusa, Louisiana, to the mouth.

(2) The basin $8.7 million multiple purpose study will be completed in 1989. Navigation studies including the existing authorized navigation on the West Pearl River, an extension of navigation on the East Pearl River for about 25 miles to Picayune, Mississippi, and navigation to Port Bienville, Mississippi, were completed in 1987. The Port Bienville local sponsor indicated they would not be financially able to cost share in the construction and maintenance of the proposed project.

(3) The reconnaissance phase of the Lower Pearl River Basin flow distribution study in being initiated in FY 1988. Problems affecting navigation and other purposes have been created by low flow and from the East Pearl River being diverted into the West Pearl River. the reconnaissance

phase will be completed in 1989 and the feasibility study in 1992. The study is 32 percent complete in 1988 and will be about 65 percent complete with funds requested for FY 1989. The federal study cost is $0.6 million out of a total cost of $1.0 million.

e. Non Fuel Taxed Waterways.

(1) The GIWW, St. Marks to Tampa is authorized for a 234 mile route skirting the shoreline from St. Marks to the Anclote River, and then along the alignment of the existing Intracoastal Waterway's nine foot channel to Tampa Bay. No work has been accomplished. An economic restudy in 1985 indicated that economic justification would be lacking without completion of the GIWW, Carrabelle to St. Marks, and the Cross Florida Barge Canal.

(2) The Mermentau, Vermilion, and Calcasieu Rivers and Bayou Teche are the subject of a $5.2 million multiple purpose basin study that includes navigation. The study is scheduled for completion in 1994, but an interim report on the Lake Charles Ship Channel will be completed in 1987. Interim reports on navigation channels to the Gulf of Mexico via the Mermentau River and from New Iberia were completed in 1975 and 1981 respectively.

(3) The Trinity River, Channel to Liberty. Texas, was authorized in 1965 as part of a multiple purpose project that included a navigation channel with locks and dams to Dallas and Fort Worth. The $1,003 million Trinity River project is now limited to the 12 foot deep and 200 foot wide multiple purpose channel that would extend from the Houston Ship Channel eastward across Trinity Bay and northward along the shore and up the Trinity River through the 600 by 84 foot Wallisville Lock and Dam to Liberty (river mile 45). A 1973 injunction court halting work in 1973, when construction was 72 percent complete, was lifted in 1987. Completion of preconstruction studies on the $175.2 million channel project are now indefinite due to the indefinite nature of project benefits. An economic reevaluation performed in FY 1986 revealed the authorized 200 foot wide channel was not feasible, but two smaller alternatives (100 foot and 75 foot width) navigation projects were potentially economically feasible. The inactive studies to prepare a supplement to the Phase I General Design Memorandum and the Environmental Impact Statement are aimed at optimization of a scaled-down navigation channel.

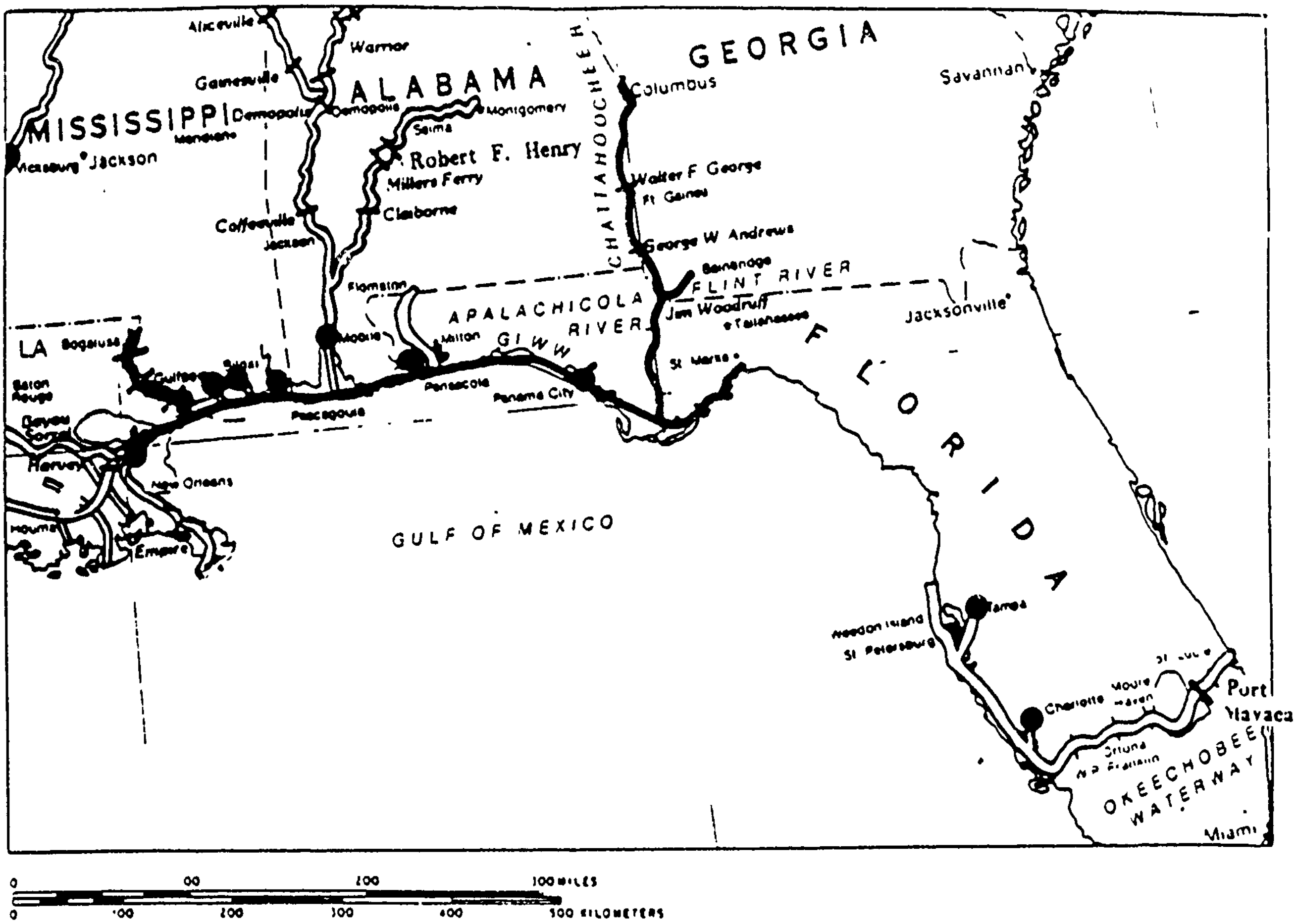
(4) The Brazos River and Tributaries $8.1 million basin multiple purpose study is determining needs and solutions for improvements for navigation and other purposes, but there is no navigation project on the river above Freeport Harbor at the Gulf Coast. The study is scheduled for completion in 1991. A study of a shorter route between Freeport and the Gulf of Mexico through the Brazos River Diversion channel for use by offshore crew and service vessels and commercial fishing boats would began in FY 1988 and will be completed in 1991. The federal study cost is $0.7 million out of a total cost of $1.0 million.

(5) The Mouth of the Colorado River, Texas, project costing $37.5 million is scheduled for completion in 1991. It is 49 percent complete and will be 66 percent complete with funds requested for FY 1989. The 6.5 mile

long, 12 by 100 foot navigation channel to Matagorda on the GIWW will benefit commercial fishing boats and oil field service vessels operating in the area and provide reliable access to the harbor of refuge on the Colorado River above Matagorda. Work in 1988 and 1989 includes initiation and completion of construction of the division channel, including levels and retaining works (59% of funds), initiation and completion of dredging in the harbor and turning basin, and initiation of dredging of the inside navigation channel, impoundment basin, and jetty entrance channel.

6. LOCK CAPACITY CHARACTERISTICS (Table A-6-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-6-4.



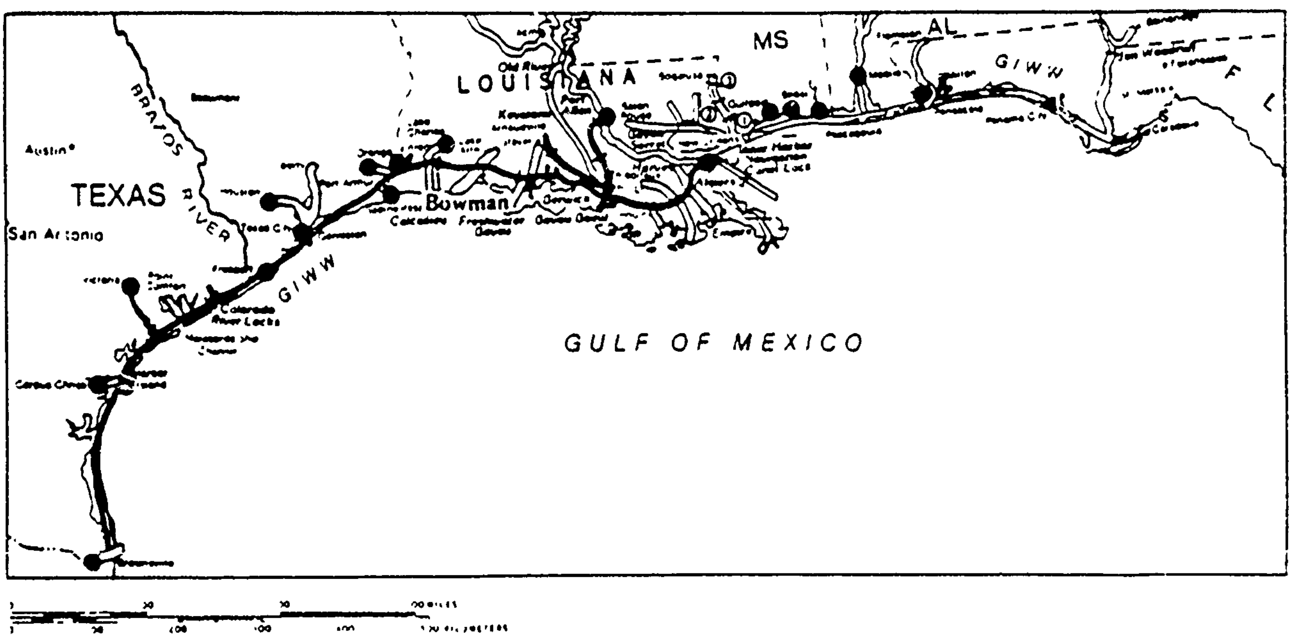


Figure A-6-1
Segment 6, GIWW

TABLE A-6-1
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Gulf Intracoastal Waterway						
Inner Harbor	92.6	1923	54	75	640	17
Harvey Lock	98.2	1935	53	75	425	20
Algiers Lock	88.0	1956	32	75	760	18
Bayou Boeuf Lock	93.3	1954	38	75	1156	11
Leland Bowman Lock	162.7	1985	3	110	1200	5
Calcasieu Lock	238.5	1950	34	75	1206	4
Brazos River E. Fldgt	404.1	1954	34	75	---	---
Brazos River W. Fldgt	404.1	1954	34	75	---	---
Colorado River E. Lock	444.8	1954	34	75	1200	5
Colorado River W. Lock	444.8	1954	34	75	1200	5
GIWW, Morgan City- Port Allen Rt.						
Port Allen	227.6	1961	27	84	1202	45
Bayou Sorrel	131.0	1952	36	56	747	21
Apalachicola, Chattahoochee, and Flint Rivers						
Jim Woodruff	106.31	1954	34	82	450	33
George W. Andrews	154.3	1962	26	82	450	25
Walter F. George	182.8	1963	25	82	450	88
Pearl River						
Lock 1	28.7	1951	37	65	310	17
Lock 2	40.8	1951	37	65	310	15
Lock 3	14.0	1951	37	65	310	11

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

TABLE A-6-2

SEGMENT NUMBER 6

GULF INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK UTILIZATION PERCENTAGE** PEAK*	LOCK UTILIZATION PERCENTAGE** 1987
GIWW										
Inner Harbor	908 (86)	548	46 (86)	44	592 (87)	592	180279 (80)	106551	100 (87)	100
Harvey Lock	144 (80)	57	34 (87)	34	134 (80)	91	13814 (80)	4012	65 (82)	47
Algiers Lock	218 (80)	217	48 (86)	45	262 (87)	262	37531 (84)	36565	90 (84)	85
Bayou Boeuf	75 (80)	16	41 (84)	25	937 (80)	41	12128 (84)	3841	76 (82)	56
Vermillion	344 (64)	N.A.	42 (84)	N.A.	386 (84)	N.A.	75072 (80)	N.A.	91 (80)	N.A.
Leland Bowman***	51 (87)	51	24 (86)	23	74 (87)	74	12111 (87)	12111	67 (85)	64
Calcasieu Lock	168 (84)	68	37 (84)	27	1010 (80)	95	24511 (81)	15661	74 (80)	72
Brazos R.E.Gate	23 (86)	N.A.	4 (84)	N.A.	26 (86)	N.A.	3590 (86)	N.A.	40 (83)	N.A.
Brazos R.W.Gate	22 (86)	N.A.	30 (80)	N.A.	30 (80)	N.A.	3292 (86)	N.A.	35 (82)	N.A.
Colorado R.E.Lk	8 (84)	N.A.	23 (80)	N.A.	29 (84)	N.A.	325 (85)	N.A.	22 (86)	N.A.
Colorado R.W.Lk	5 (85)	N.A.	25 (80)	N.A.	27 (80)	N.A.	681 (85)	N.A.	21 (86)	N.A.
GIWW, Morgan City - Port Allen										
Port Allen	86 (84)	77	65 (84)	59	151 (84)	136	10723 (84)	6688	77 (84)	78
Bayou Sorrel	88 (84)	62	39 (84)	28	177 (80)	90	9049 (86)	5315	60 (82)	41

TABLE A-6-2 (Continued)
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW						TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	DELAY** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)					
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Apalachicola, Chattahoochee										
Jim Woodruff	56 (81)	N.A.	30 (85)	N.A.	84 (81)	N.A.	749 (81)	N.A.	76 (85)	N.A.
George W. Andrew	59 (82)	N.A.	26 (85)	N.A.	81 (82)	N.A.	153 (80)	N.A.	78 (85)	N.A.
Walter F. George	16 (83)	N.A.	42 (80)	N.A.	53 (80)	N.A.	18 (83)	N.A.	76 (85)	N.A.
Pearl River										
Lock 1			DATA	NOT	AVAILABLE					
Lock 2			DATA	NOT	AVAILABLE					
Lock 3			DATA	NOT	AVAILABLE					

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year
*** Leland Bowman is a replacement lock for Vermillion and went into operation April 1985.
N.A. = Not Available
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-6-2

SEGMENT NUMBER 6

GULF INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION ***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
(PEAK YEAR)*	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
GIWW																
Inner Harbor	1464 (87)	1464	953 (86)	87	2139 (85)	65	2698 (86)	1616	180 (84)	81	12 (80)	6	423 (84)	328	610 (84)	415
Harvey Lock	877 (81)	36	50 (86)	10	2875 (81)	91	3755 (81)	137	58 (81)	25	17 (85)	8	427 (80)	252	472 (80)	285
Algiers Lock	1566 (80)	145	67 (85)	16	70 (81)	4	1608 (80)	165	48 (80)	8	31 (85)	5	45 (80)	3	92 (81)	16
Bayou Boeuf	1330 (80)	118	618 (82)	15	45 (85)	37	1352 (80)	170	37 (85)	35	15 (84)	3	38 (84)	23	75 (84)	60
Leland Bowman	52 (86)	5	0**	0	8 (86)	0	60 (86)	5	25 (86)	2	28 (86)	13	64 (86)	1	21 (86)	16
Calcasieu Lock	2178 (80)	196	4 (81)	0	2044 (85)	69	3646 (80)	265	60 (87)	60	134 (87)	134	97 (87)	97	291 (87)	291
Brazos R.E.Gate	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.
Brazos R.W.Gate	10 (82)	N.A.	0	N.A.	0	N.A.	10 (82)	N.A.	2 (82)	N.A.	0	N.A.	0	N.A.	2 (82)	N.A.
Colorado R.E.Lk	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	1 (82)	N.A.	0	N.A.
Colorado R.W.Lk	0	N.A.	0	N.A.	4 (82)	N.A.	4 (82)	N.A.	0	N.A.	0	N.A.	1 (82)	N.A.	1 (82)	N.A.
GIWW, Morgan City - Port Allen																
Port Allen	69 (81)	11	919 (86)	6	2385 (87)	2385	2402 (87)	2402	23 (80)	15	15 (81)	5	119 (87)	119	144 (80)	139
Bayou Sorrel	181 (87)	181	745 (84)	17	15 (87)	15	753 (84)	213	54 (87)	54	7 (82)	4	8 (80)	7	65 (87)	65
Apalachicola, Chattahoochee, & Flint R.																
Jim Woodruff	1 (83)	N.A.	2 (83)	N.A.	739 (81)	N.A.	739 (81)	N.A.	1 (83)	N.A.	1 (83)	N.A.	59 (80)	N.A.	58 (80)	N.A.
George W. Andrew	153 (82)	N.A.	0	N.A.	0	N.A.	153 (82)	N.A.	1 (82)	N.A.	0	N.A.	0	N.A.	1 (82)	N.A.
Walter F. George	0	N.A.	4 (83)	N.A.	14 (83)	N.A.	18 (83)	N.A.	1 (80)	N.A.	1 (83)	N.A.	15 (80)	N.A.	16 (80)	N.A.

TABLE A-6-2(CONTINUED)
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK* (PEAK YEAR)	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Pearl River																
Lock 1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = Not Available

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.

** Zero indicates that no data is available.

*** Leland Bowman is a replacement lock for Vermillion and went into operation April 1985.

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-6-3

SEGMENT NUMBER 6

GULF INTRACOASTAL WATERWAY TRAFFIC

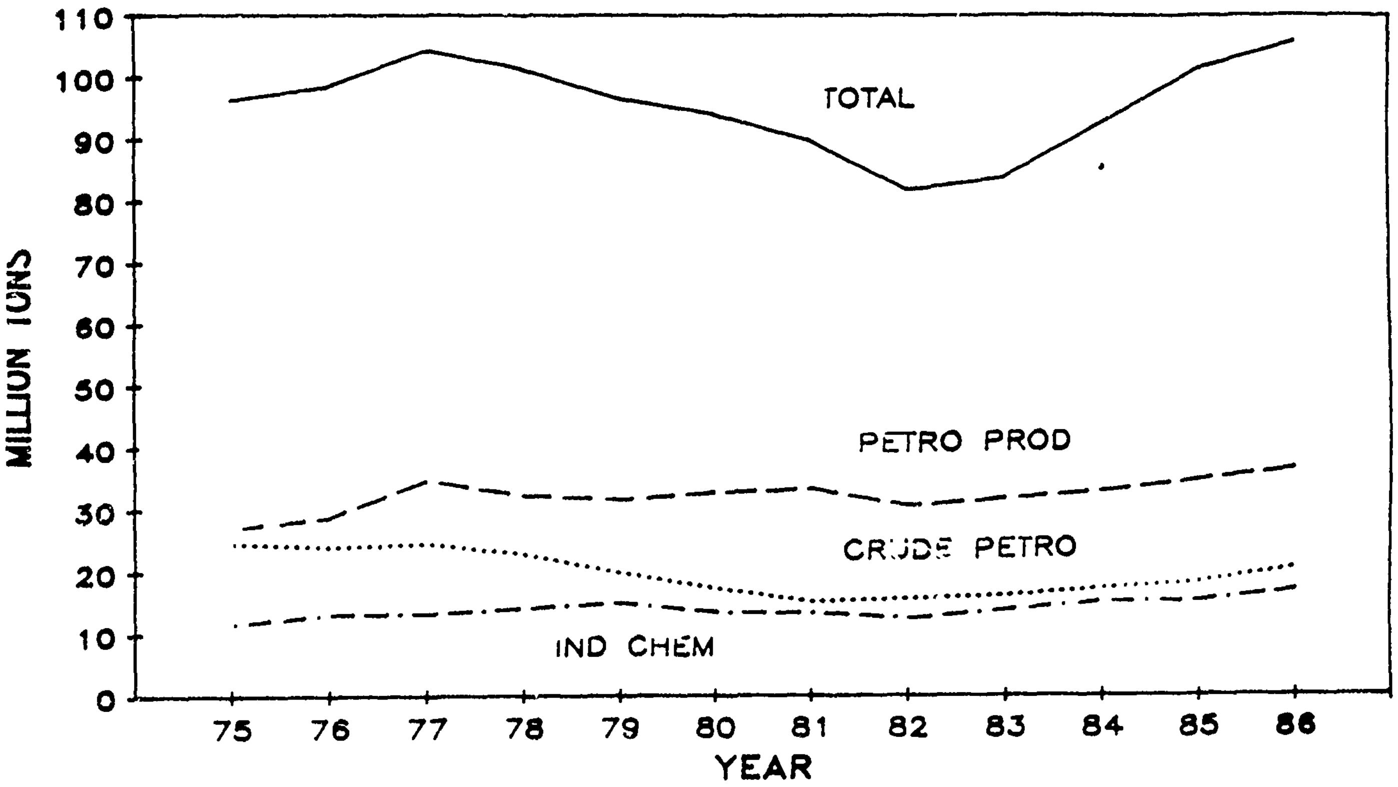
1975-1986

(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	2347	2197	1704	1558	1161	1100	939	810	872	1059	1165	1429
Other Agricultural Prdcts	519	423	522	511	541	590	584	594	573	465	682	904
Metallic Ores	140	310	331	344	403	364	399	147	803	213	168	167
Coal	4298	4754	4221	4016	4971	5066	4646	4006	3905	6792	7213	8792
Crude Petroleum	24573	24242	24747	22929	20000	17460	15191	15584	16060	17421	18387	20713
Non-Metlc Minerals & Prod	9962	10445	9977	10712	9678	9220	7651	7701	7685	8852	10689	9519
Lumber, Wood Prod. & Pulp	374	339	295	560	408	321	300	228	221	197	278	208
Industrial Chemicals	11655	13196	13334	14224	15023	13456	13422	12498	13900	15179	15364	17096
Agricultural Chemicals	1161	1123	1448	1519	1555	1581	1392	1375	1391	1460	1184	1114
Petroleum Prdcts	27137	28792	34679	32299	31676	32882	33503	30704	31859	33055	34923	36682
Metallic Products & Scrap	2505	2467	2346	2946	3070	3802	4161	2263	1777	2736	3485	2990
All Other Commodities	11775	10265	10702	9815	8160	8234	7687	5971	4719	4977	7774	7774
Of Which Marine Prodcts	9807	7467	7958	7158	5609	5937	5159	3923	3146	3029	3247	2732
TOTAL	96446	98553	104306	101433	96646	94076	89875	81881	83765	92406	101312	105697

SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-6-2
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-6-3
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000

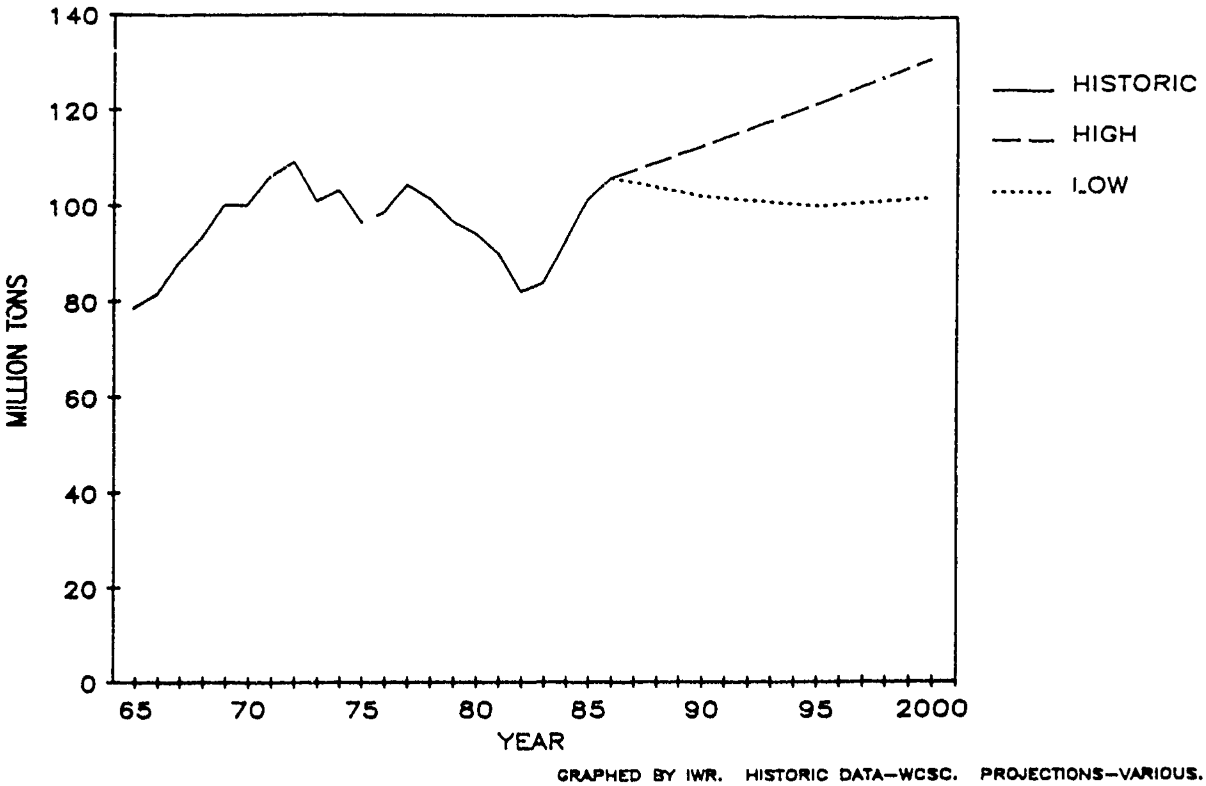


TABLE A-6-4
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
Inner Harbor	25.3	-0.2%	24.0	26.6	26.3	10.6	15.7	12.9	11.9	11.9	6.0	5.9	1.9	2.2	2.2	2	3	3
Harvey Lock	7.7	-8.7%	3.5	3.9	3.5	1.9	1.6	4.8	5.0	4.5	2.3	2.2	0.7	0.8	0.8	2	2	2
Algiers Lock	23.2	0.6%	23.4	25.1	26.7	15.2	11.5	10.6	10.2	10.3	4.8	5.5	2.2	2.5	2.6	2	2	3
Bayou Boeuf	31.0	-2.1%	25.1	25.7	27.2	14.3	12.9	20.1	15.6	16.8	8.0	8.8	1.3	1.7	1.6	2	2	2
Leland Bowman	43.0	-0.3%	45.3	41.6	42.4	23.1	19.3	4.4	14.4	14.2	7.1	7.1	3.3	2.9	3.0	3	N.A.	3
Calcasieu Lock	43.8	-1.1%	40.2	41.2	42.2	21.6	20.6	14.1	14.0	13.8	6.9	6.9	2.9	2.9	3.1	3	3	3
Brazos R.E.Gate	N.A.	N.A.	17.8	19.0	N.A.	N.A.	N.A.	7.7	9.4	N.A.	N.A.	N.A.	1.8	1.9	N.A.	2	2	N.A.
Brazos R.W.Gate	N.A.	N.A.	17.2	18.0	N.A.	N.A.	N.A.	7.3	9.1	N.A.	N.A.	N.A.	1.9	1.9	N.A.	2	2	N.A.
Colorado R.E.Lk	N.A.	N.A.	17.4	18.5	N.A.	N.A.	N.A.	9.1	8.1	N.A.	N.A.	N.A.	2.2	2.3	N.A.	2	2	N.A.
Colorado R.W.Lk	N.A.	N.A.	17.1	17.9	N.A.	N.A.	N.A.	8.6	7.5	N.A.	N.A.	N.A.	2.3	2.4	N.A.	2	2	N.A.
Port Allen (1)	14.2	1.9%	25.3	23.5	19.2	12.0	7.2	7.1	6.8	5.5	3.1	2.4	3.7	3.5	3.5	3	3	3
Bayou Sorrel	N.A.	N.A.	21.6	22.4	22.0	14.1	7.9	7.2	7.0	5.8	3.3	2.5	2.9	3.3	3.8	3	3	3
Jim Woodruff	1.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.3	N.A.	N.A.	N.A.	N.A.	1.1	N.A.	N.A.	2	N.A.	N.A.
George W. Andre	0.4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	1.1	N.A.	N.A.	1	N.A.	N.A.
Walter F. Georg	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	1.1	N.A.	N.A.	1	N.A.	N.A.
Lock 1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.
Lock 2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = NOT AVAILABLE
SOURCE: Lock Performarce Monitoring System (PMS), Corps of Engineers, 1986.
(1) September and October 1987 tonnage not included in Total. Not available from PMS data.

TABLE A-6-5
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENENCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
GIWW										
GIWW	17,683	19,471	17,801	17,570	23,265	27,026	29,934	26,420	27,152	29,814
Ap/Cha/Flt	4,963	6,948	5,704	6,881	7,535	6,703	5,668	8,525	8,468	7,697
Pearl R	115	105	161	116	114	172	203	411	293	244
Subtotal	22,761	26,524	23,666	24,567	30,914	33,901	35,805	35,356	35,913	[illegible]

TON MILES OF TRAFFIC (000) CY 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
GIWW										
GIWW	19,680,722	19,091,243	18,920,693	19,077,020	17,693,882	16,296,474	15,537,363	17,206,651	14,700,202	19,032,024
Ap/Cha/Flt	135,546	102,995	97,187	81,956	62,534	100,664	80,328	129,730	128,984	86,849
Pearl R	3,788	194	136	1,781	865	646	514	528	308	691
Subtotal	19,820,056	19,194,432	19,018,016	19,160,757	17,757,281	16,397,784	15,618,205	17,336,909	14,829,494	19,119,564

O & M COSTS PER TON MILE ($) 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
GIWW										
GIWW	0.0009	0.0010	0.0009	0.0009	0.0013	0.0017	0.0019	0.0015	0.0018	0.0016
Ap/Cha/Flt	0.0366	0.0675	0.0587	0.0840	0.1205	0.0666	0.0706	0.0657	0.0657	0.0886
Pearl R	0.0304	0.5412	1.1838	0.0651	0.1318	0.2663	0.3949	0.7784	0.9513	0.3531
Segment	0.0011	0.0014	0.0012	0.0013	0.0017	0.0021	0.0023	0.0020	0.0024	0.0020

NOTE: FY 1987 costs in order by the waterway(s) above are 28,664, 9,448, and 117, respectively, and the subtotal is 38,229.
1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-6-6
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
GULF INTRACOASTAL WATERWAY								
Inner Harbor	SCF	1987	1990	1,600	0	1,050	66	500
	CCNF	Unk	Unk	685,489	193,400	90,000	13	0
GIWW, LA AND TX	SCF	1976	1990	4,350	0	3,676	85	210
GIWW, Channel to Victoria	SAS	1988	1991	650	0	0	0	250
	CINA	Unk	Unk	23,900	11,750	0	0	0
GIWW,Carrabelle	SC (1)	1965	1973	51	0	51	100	0
-St. Marks	CANS	Unk	Unk	Unk	0	0	0	0
APALACHICOLA, CHATTAHOOCHEE, AND FLINT RIVERS								
Basin Water Mgmt. Plan	SCF	1985	1988	2,281 (2)	0	2,281 (2)	100 (2)	0 (2)
PEARL RIVER								
Basin Multiple Purpose	SCF	1963	1989	8,760	0	8,638	99	122
Lower R. Flow Dist.	SCF	1988	1992	1,040	0	200	19	200

TABLE A-6-6(continued)
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
GIWW, St. Marks to Tampa (Non Fuel Taxed Waterway)								
Channel	SCNF	1984	Unk	Unk	Unk	39	Unk	Unk
	CANS(3)	Unk	Unk	Unk	0	Unk	Unk	0
MERMENTAU, VERMILION, AND CALCASIEU RIVERS AND BAYOU TECHE (NON FUEL TAXED WATERWAY)								
Basin Multiple Purpose	SCF	1964	1994	5,233	0	3,341	64	510
TRINITY RIVER (NON FUEL TAXED WATERWAY)								
Channel to Liberty Incl.	SCNF	1967	Unk	3,500 (5)	0	2,342 (5)	67	0
Wallisville L&D	CCNF	1970	Unk	175,200 (5)	0	126,144 (5)	72 (4)	0
BRAZOS RIVER (NON FUEL TAXED WATERWAY)								
Basin Multiple Purpose	SCF	Unk	1991	8,130	0	6,856	84	400
Diversion Channel	SCF	1987	1991	700	0	380	54	100

TABLE A-6-6(continued)
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
COLORADO RIVER (NON FUEL TAXED WATERWAY)								
Mouth to Matagorda	CCF	1979	1991	37,453	0	15,865	49	5,800

(1) Unfavorable report.
(2) Total amounts for the waterway.
(3) Economic justifiction depends on completion of the Cross Florida Barge Canal, which was deauthorized in 1986.
(4) Construction of Wallisville Lock and Dam was 72 percent complete when halted by court order in 1973. The court order was lifted in 1987.
(5) Costs are for multiple purpose flood control project, of which navigation is one purpose.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-6-7
SEGMENT NUMBER 6
GULF INTRACOASTAL WATERWAY

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Inner Harbor	1923	30	35	25.3	24.0	28.2	26.3	-5.1	11.5	N.A.	87.7%	75.1%	100
Harvey Lock	1934	11	14	7.7	3.5	3.9	3.5	-54.5	-49.4	-54.5	31.8%	25.0%	47
Algiers Lock	1956	26	29	23.2	23.4	24.6	26.7	0.9	6.0	15.1	102.7%	92.1%	85
Bayou Bo[illegible]	1954	36	45	31.0	25.1	25.7	27.2	-19.0	-17.1	-12.3	75.6%	60.4%	56
Leland Bowman	1933		NC	43.0	45.3	41.6	42.4	5.3	-3.3	-1.4	N.A.	N.A.	64
Calcasieu lock	1982		60	43.8	40.2	41.2	42.2	-8.2	-5.9	-3.7	N.A.	70.3%	72
Brazos R.E.Gate	1954		NC	N.A.	17.8	19.0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Brazos R.W.Gate	1954		NC	N.A.	17.2	18.0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Colorado R.E.Lk	1954		NC	N.A.	17.4	18.5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Colorado R.W.Lk	1954		NC	N.A.	17.1	17.9	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Port Allen(4)		32	35	14.2	25.3	23.5	19.2	78.2	105.6	35.2	60.0%	54.9%	78
Bayou Sorrel		61	69	N.A.	21.6	22.4	22.0	N.A.	N.A.	N.A.	36.1%	31.9%	41
Jim Woodruff	1954	13	15	1.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
George W. Andrw	1962		9	0.4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Walter F. George	1963		10	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 1				N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 2				N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Lock 3				N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987
(4) September and October 1987 tonnage not included in Total.

SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-7-1). The Mobile-Tombigbee-Black Warrior Rivers system is 453 miles long from Mobile Bay to the head of navigation northwest of Birmingham on Locust, Mulberry, and Sipsey Forks. The Alabama River project length is 305 miles from its junction with the Tombigbee River to form the Mobile River to Wetumpka, about 10 miles above Montgomery. The Coosa River is 286 miles long from Wetumpka to Rome, Georgia, but that portion of the authorized project has not been developed for navigation. The Tennessee-Tombigbee Waterway, which extends from its junction with the Tennessee River near the intersection of the Tennessee, Alabama, and Mississippi state borders to the confluence of the Black Warrior River with the Tombigbee River, is 234 miles long. The project depth is nine feet except for twelve feet in the canal and divide sections of the Tennessee-Tombigbee Waterway. The project width is 200 feet on the rivers and 300 feet on the waterway, except for 280 feet in the divide cut.

b. Locks (Table A-7-1). The locks are 600 feet long, except at Oliver Lock and Dam, which has a 460 foot length. Lock widths are 110 feet or 84 feet on the Alabama River, except for 95 feet at Oliver Lock and Dam. Lock lifts range from 30 to 48 feet on the Alabama River, 22 to 68 feet on the Black Warrior-Tombigbee Rivers, and 25 to 84 feet on the waterway. Average lift for the locks on the three waterways is 41, 43, and 34 feet, respectively. All the facilities are 34 years old or younger, except for Oliver Lock and Dam, which is 49 years old.

2. PERFORMANCE CHARACTERISTICS (Table A-7-2).

Data are unavailable for this waterway for 1987. The total peak average processing time ranged from 35 minutes (1983) for Claiborne to 2,879 minutes or 47.98 hours (1984) for Selden (Warrior). Selden (Warrior) lock had the highest total peak processing time for the 1980-1987 time period of 2879 minutes in 1984. The peak total delay varies from 1 hour (1985) for Lock E to 7711 hours (1981) for William Bacon Oliver. From 1980 through 1987, the highest peak total delay was 7711 hours for William Bacon Oliver in 1981. The peak lock utilization rate for 1980-1987 ranged from 74% (1985) to 92% (1985). Based on the peak utilization data 1985 seems to have been the busiest year for this waterway segment. All the locks had peak utilization rates in the year 1985. However, William Bacon Oliver had the highest peak utilization of 92% (1985) for the 1980-1987 time period. The total peak downtime from 1980-1987 ranged from 0 hours to 4653 hours in 1981. The highest peak total downtime hours for the 1980-1987 time period occurred at Demopolis lock in 1981 (4653 hours). Peak stall events ranged from 0 to 238 (1980). From 1980 through 1987, the highest peak number of stall events was 238 in 1980 for Selden (Warrior) lock.

3. COMMODITY TRAFFIC (Tables A-2, A-7-3A,-4); (Figure A-7-2,-3).

a. Historical. Traffic on the Black Warrior-Tombigbee Waterway component of the Mobile River and Tributaries segment reached a peak in 1984 of 19.6 million tons when coal movements were at record levels. The other waterways

feeding into this system carry much smaller, though increasing, volumes of traffic. Traffic on the Alabama River and the Tennessee-Tombigbee Waterway reached 4.1 and 3.6 million tons, respectively, in 1986. Black Warrior -Tombigbee traffic has fluctuated from year to year, but generally increased from 1965 (7.8 million tons) to 1980 (16.7 million tons). A decline to 14.7 million tons occurred by 1983 before the sudden upsurge in 1984. Total tonnage declined in 1985 to 18.9 million and then declined again in 1986 to 17.9 million tons as coal movements continued to fall. Coal is the principal commodity (55 percent in 1986). Metallic ores and products have also been historically significant, although this group declined precipitously after 1981. More recently, metallic ores and products traffic has been regaining lost share, reaching nearly 2 million tons in 1986, the highest level since 1981. Forest products traffic, only minor historically, have shot up from 0.2 to 2.8 million tons between 1983 and 1986, making this the second largest commodity group.

b. Forecast. Between 1986 and 2000, waterborne commerce on the Black Warrior and Tombigbee Rivers, which dominate traffic on the Mobile River and Tributaries segment, is projected to increase from 17.9 million tons to between 21.3 and 30.2 million tons by 2000. The forecast growth in total traffic is strenthened somewhat by projected national trends for growth in coal. Coal accounted for 55 percent of all tons in 1986 and exerts a dominant influence in future traffic forecasts. Coal shipments should benefit from increased demand by electric utilities in the out-years of the forecast period, but coal exports are projected to grow only modestly. Of the other important commodities on the Black Warrior River, forest products (16 percent of total 1986 traffic) should show significant growth (although perhaps not as high as the 1984-86 rate of growth), as lumber production continues its shift to the southeastern U.S. and wood processing and paper plants continue to increase production.

c. Tonnages at Locks. Based on average annual percent change during 1977-1984 period, there was an increase in tonnage for all six locks on the Black Warrior-Tombigbee. The percentage increase in tonnage per annum ranged from 9.1% (Bankhead) to 13.0 (Demopolis). Lock traffic data is currently unavailable for the period since 1984.

4. OPERATION AND MAINTENANCE COSTS (Table A-7-5).

O&M costs in actual dollars increased from about $7 million dollars in 1977 to about $23 million dollars in 1986, about a 94% increase when adjusted for inflation of about 68% during the same period. Traffic increased from about 4 million ton-miles in 1977 to about 6.0 million ton-miles in 1985, about a 50% increase. O&M cost per ton-mile rose from 1.6 mills in 1977 to 4.1 mills in 1986 as increases in costs outpaced traffic growth. This segment ranked the sixth lowest in cost per ton-mile of all nine segments.

5. PROGRAM STATUS (Table A-7-6).

a. Overview. This segment includes a recently completed project, one under construction, a third authorized for construction with preconstruction studies nearly complete, and a feasibility study.

b. The Tennessee-Tombigbee Waterway opened in 1985 well ahead of schedule and 13 years after construction began in 1972 at a cost of $1,790 million. The 234 mile project connecting the Ohio River valley with the eastern Gulf Coast features a 9 to 12 foot channel with a 300 foot width (except 280-feet in the divide cut), ten locks, and five dams.

c. William Bacon Oliver Lock and Dam is under construction on the Black Warrior River with a single 600 by 110 foot chamber and dam to replace the existing 460 by 95 foot lock and its dam. The $121 million project, scheduled for completion in 1992, will eliminate the need for multiple locking for the standard six barge tows using the system, reduce lockage time, and increase the traffic capacity. It is 33 percent complete in 1988 and will be 62 percent with funds requested for FY 1989. Work in 1988 and 1989 includes completion of the cofferdam and river diversion contract and initiation and continuation of lock and dam construction (about 85 percent of costs).

d. Black Warrior and Tombigbee Rivers. A study to determine the advisability of modifying the existing project, particularly Coffeeville and Demopolis Locks and Dams and the related channel, was included in a final report completed in 1985. Additional studies concerning navigation efficiency of the existing waterway, navigation to Birmingham, lockage water shortage, and environmental studies concerning the waterway south of Demopolis were also included in the report. No improvements in navigation were recommended.

e. The Coosa River, Montgomery to Gadsden (Non Fuel Taxed Waterway), was initially authorized in 1945 to include installing 600 by 84 foot locks in five of the seven Alabama Power Company dams and constructing a 9 by 150 foot channel. Preconstruction studies began in 1978 on the reach between Montgomery and Gadsden, Alabama, and they are now 92 percent complete. Completed studies include the feature design memorandum, plans and specifications, railroad relocation study general model, and filling and emptying model for the first lock and railroad relocation and general model studies for several other locks. An economic evaluation restudy is being done in 1988 with $300,000 of the $1 million appropriated. Construction could be initiated within a year after appropriations are received and completed in about ten years. The plan was further modified by PL 99-662 (Section 813) to authorize the Secretary to carry out the planning, engineering and design for a project generally in accordance with the plans contained in the report entitled "Montgomery to Gadsden, Coosa River Channel, Alabama, Design Memorandum No. 1, General Design," May 1982.

f. Coosa River, Gadsden to Rome (Non Fuel Taxed Waterway). Plans for the extension from Gadsden to Rome, Georgia, have been deferred until the extension to Gadsden is assured.

6. LOCK CAPACITY CHARACTERISTICS (Table A-7-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-7-4.

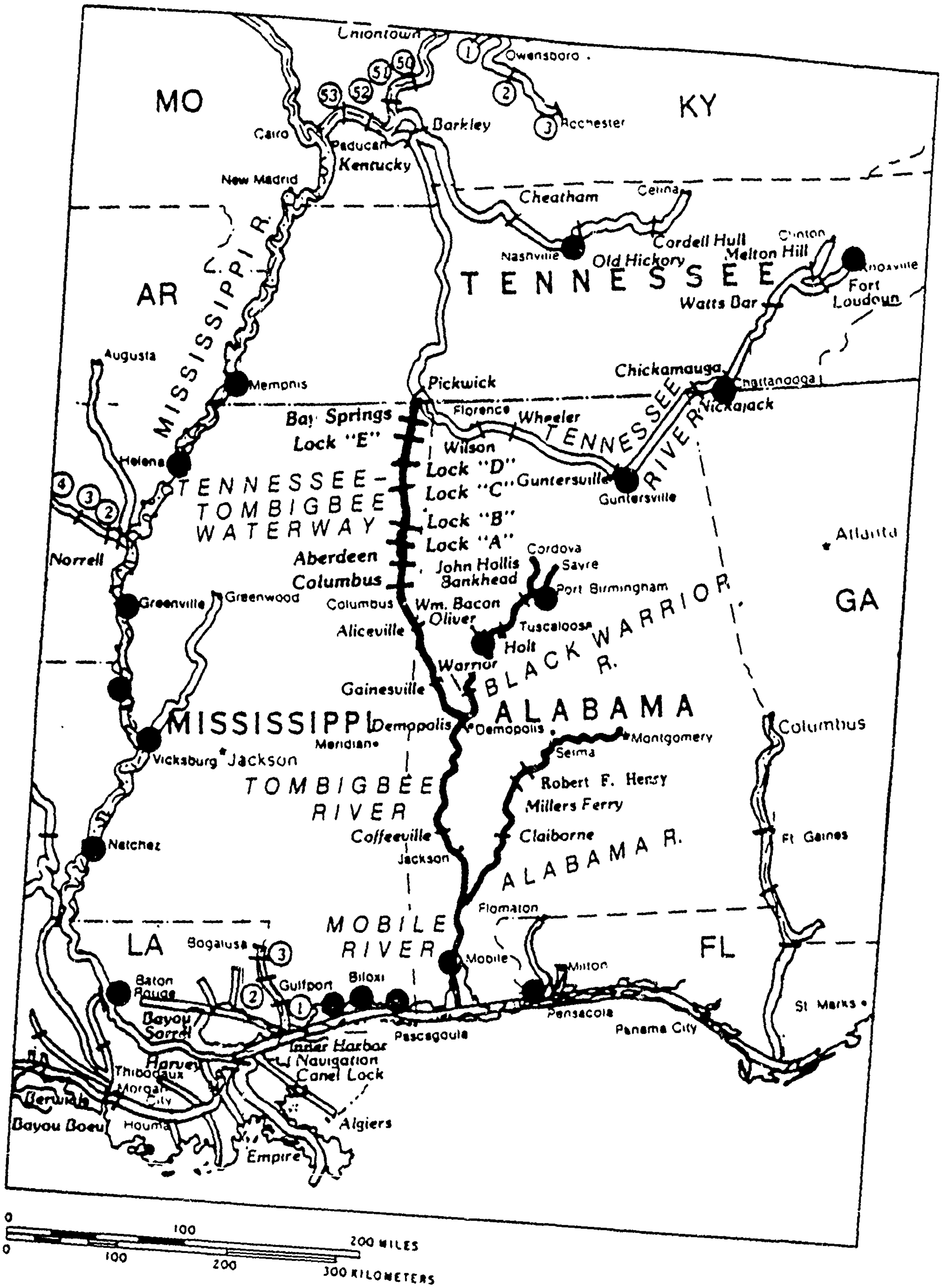


Figure A-7-1
Segment 7, Mobile River System

TABLE A-7-1
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Black Warrior River						
John Hollis Bankhead	365.7	1975	13	110	600	68
Holt	347.0	1966	22	110	600	64
Wm. Bacon Oliver	338.1	1939	49	95	460	28
Wm. Bacon (u. const)	337.6	1991	—	110	600	28
Selden (Warrior)	261.7	1957	31	110	600	22
Tombigbee River						
Demopolis	213.2	1954	34	110	600	40
Coffeeville	116.6	1960	28	110	600	34
Alabama River						
Claiborne	81.2	1969	19	84	600	30
Millers Ferry	142.3	1969	19	84	600	48
Robert F. Henry	245.4	1972	16	84	600	45
Tennessee-Tombigbee WW						
Gainesville	49.1	1978	10	110	600	36
Aliceville	89.8	1979	9	110	600	27
Columbus	117.6	1980	8	110	600	27
Aberdeen	140.0	1985	2	110	600	27
A	154.0	1985	2	110	600	30
B	159.3	1985	2	110	600	25
C	174.0	1985	2	110	600	25
D	181.0	1985	2	110	600	30
E	189.0	1985	2	110	600	30
Bay Springs	194.9	1985	2	110	600	84

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986

TABLE A-7-2

SEGMENT NUMBER 7

MOBILE RIVER AND TRIBUTARIES

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
Bankhead	64 (81)	N.A.	46 (84)	N.A.	110 (81)	N.A.	3151 (81)	N.A.	82 (85)	N.A.
Holt	58 (81)	N.A.	55 (81)	N.A.	113 (81)	N.A.	3442 (81)	N.A.	85 (85)	N.A.
Wm. Bacon Oliver	159 (85)	N.A.	85 (85)	N.A.	244 (85)	N.A.	7711 (81)	N.A.	92 (85)	N.A.
Selden (Warrior)	66 (80)	N.A.	83 (84)	N.A.	2879 (84)	N.A.	4311 (80)	N.A.	84 (85)	N.A.
Demopolis	96 (81)	N.A.	50 (81)	N.A.	146 (81)	N.A.	5762 (81)	N.A.	85 (85)	N.A.
Coffeeville	59 (82)	N.A.	45 (80)	N.A.	101 (82)	N.A.	3905 (82)	N.A.	84 (85)	N.A.
Claiborne	3 (83)	N.A.	32 (84)	N.A.	35 (83)	N.A.	27 (83)	N.A.	79 (85)	N.A.
Millers Ferry	71 (84)	N.A.	46 (81)	N.A.	112 (84)	N.A.	18 (81)	N.A.	74 (85)	N.A.
Robert F. Henry	2 (84)	N.A.	37 (83)	N.A.	132 (84)	N.A.	3 (81)	N.A.	79 (85)	N.A.
Gainesville	30 (81)	N.A.	46 (81)	N.A.	76 (81)	N.A.	29 (81)	N.A.	78 (85)	N.A.
Aliceville	6 (80)	N.A.	32 (85)	N.A.	37 (80)	N.A.	5 (85)	N.A.	79 (85)	N.A.
Columbus	28 (82)	N.A.	33 (85)	N.A.	60 (82)	N.A.	27 (82)	N.A.	78 (85)	N.A.
Aberdeen	2 (85)	N.A.	38 (85)	N.A.	40 (85)	N.A.	5 (85)	N.A.	78 (85)	N.A.
A	4 (85)	N.A.	35 (85)	N.A.	39 (85)	N.A.	9 (85)	N.A.	78 (85)	N.A
B	1 (85)	N.A.	40 (85)	N.A.	41 (85)	N.A.	3 (85)	N.A.	78 (85)	N.A.
C	5 (85)	N.A.	43 (85)	N.A.	48 (85)	N.A.	9 (85)	N.A.	78 (85)	N.A.
D	4 (85)	N.A.	31 (85)	N.A.	N.A.	N.A.	7 (85)	N.A.	78 (85)	N.A.

TABLE A-7-2 (Continued)
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW						TOTAL DELAY** (HOURS)		LOCK** UTILIZATION PERCENTAGE	
	DELAY ** (MIN)		LOCKAGE** (MIN)		TOTAL** (MIN)					
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
E	0	N.A.	35 (85)	N.A.	35 (85)	N.A.	1 (85)	N.A.	78 (85)	N.A.
Bay Springs	3 (85)	N.A.	38 (85)	N.A.	41 (85)	N.A.	3 (85)	N.A.	79 (85)	N.A.

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.
** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls
** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls
** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl
** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)
** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year
N.A. = Not Available
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-7-2
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Bankhead	22 (83)	N.A.	21 (80)	N.A.	35 (80)	N.A.	63 (80)	N.A.	28 (80)	N.A.	8 (80)	N.A.	105 (80)	N.A.	137 (80)	N.A.
Holt	922 (81)	N.A.	77 (81)	N.A.	106 (81)	N.A.	1105 (81)	N.A.	46 (81)	N.A.	8 (81)	N.A.	17 (80)	N.A.	69 (81)	N.A.
Wm. Bacon Oliver	106 (85)	N.A.	108 (81)	N.A.	56 (82)	N.A.	170 (82)	N.A.	19 (82)	N.A.	22 (80)	N.A.	29 (82)	N.A.	64 (82)	N.A.
Selden (Warrior)	314 (83)	N.A.	22 (80)	N.A.	2904 (80)	N.A.	3216 (80)	N.A.	6 (80)	N.A.	5 (80)	N.A.	229 (80)	N.A.	238 (80)	N.A.
Demopolis	3231 (81)	N.A.	4 (81)	N.A.	1784 (80)	N.A.	4653 (81)	N.A.	39 (80)	N.A.	2 (83)	N.A.	183 (80)	N.A.	221 (80)	N.A.
Coffeeville	34 (82)	N.A.	15 (82)	N.A.	2894 (80)	N.A.	2943 (82)	N.A.	35 (81)	N.A.	9 (82)	N.A.	125 (81)	N.A.	162 (81)	N.A.
Claiborne	2 (80)	N.A.	6 (80)	N.A.	2 (83)	N.A.	8 (80)	N.A.	1 (83)	N.A.	1 (83)	N.A.	2 (83)	N.A.	3 (83)	N.A.
Millers Ferry	3 (83)	N.A.	0**	N.A.	12 (81)	N.A.	12 (81)	N.A.	3 (83)	N.A.	1 (80)	N.A.	3 (82)	N.A.	6 (82)	N.A.
Robert F. Henry	0	N.A.	1 (80)	N.A.	2 (81)	N.A.	2 (81)	N.A.	0	N.A.	1 (80)	N.A.	1 (81)	N.A.	1 (81)	N.A.
Gainesville	2 (80)	N.A.	0	N.A.	8 (80)	N.A.	10 (80)	N.A.	3 (85)	N.A.	0	N.A.	7 (83)	N.A.	7 (83)	N.A.
Aliceville	3 (85)	N.A.	0	N.A.	1 (83)	N.A.	3 (85)	N.A.	1 (85)	N.A.	0	N.A.	2 (83)	N.A.	2 (85)	N.A.
Columbus	13 (82)	N.A.	0	N.A.	0	N.A.	13 (82)	N.A.	1 (82)	N.A.	0	N.A.	0	N.A.	1 (82)	N.A.
Aberdeen	0	N.A.	0	N.A.	2 (85)	N.A.	2 (85)	N.A.	0	N.A.	0	N.A.	8 (85)	N.A.	8 (85)	N.A.
A	0	N.A.	9 (85)	N.A.	0	N.A.	9 (85)	N.A.	0	N.A.	1 (85)	N.A.	0	N.A.	1 (85)	N.A.
B	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	1 (85)	N.A.	1 (85)	N.A.
C	0	N.A.	0	N.A.	3 (85)	N.A.	3 (85)	N.A.	0	N.A.	0	N.A.	4 (85)	N.A.	4 (85)	N.A.
D	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.

TABLE A-7-2 (Continued)
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR) *	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
E	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.	0	N.A.
Bay Springs	0	N.A.	0	N.A.	3 (85)	N.A.	3 (85)	N.A.	0	N.A.	0	N.A.	3 (85)	N.A.	3 (85)	N.A.

N.A. = Not Available

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.

** Zero indicates that no data is available.

*** Total Downtime Hours by Condition and Total No. of Scall Events by Condition are calculated the following way:

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-7-3

SEGMENT NUMBER 7

BLACK WARRIOR/TOMBIGBEE RIVERS TRAFFIC

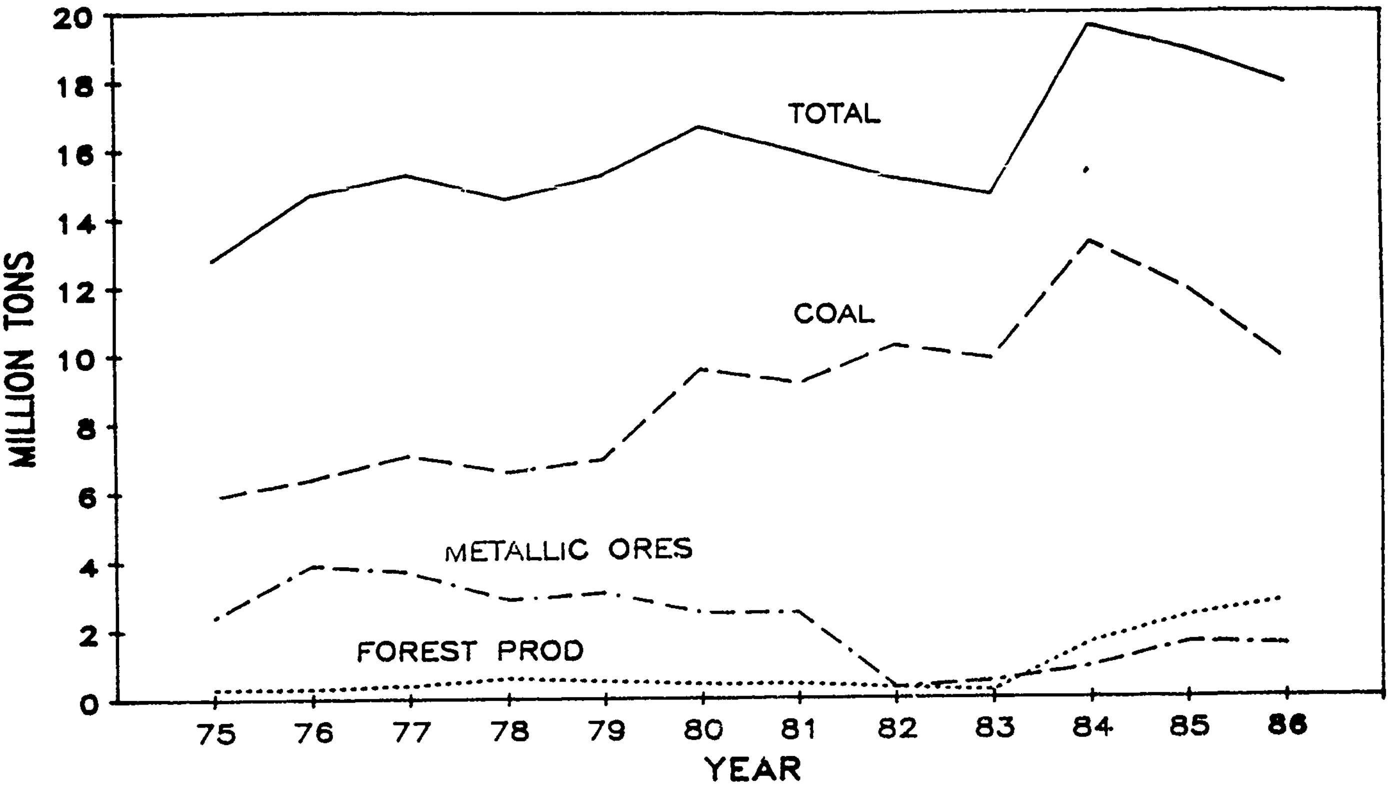
1975-1986

(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	153	172	285	200	221	156	187	224	140	232	194	218
Other Agricultural Prdcts	1	0	0	2	4	8	0	6	10	4	30	36
Metallic Ores	2440	3890	3725	2862	3141	2465	2496	326	482	899	1579	1524
Coal	5930	6395	7090	6571	7044	9646	9239	10293	9909	13282	11935	9796
Crude Petroleum	605	547	573	611	583	513	447	658	610	584	495	617
Non-Metlc Minerals & Prod	2429	1955	1818	1979	2039	1611	1930	2338	2483	2203	1171	1453
Lumber, Wood Prod. & Pulp	314	298	373	634	496	437	410	293	233	1631	2369	2832
Industrial Chemicals	425	468	478	381	436	374	384	253	149	175	244	322
Agricultural Chemicals	0	0	28	99	64	74	49	41	38	39	76	70
Petroleum Prdcts	232	367	303	565	581	690	378	505	417	287	378	465
Metallic Products & Scrap	214	557	521	578	383	374	295	204	109	233	316	430
All Other Commodities	55	57	93	119	319	360	147	19	97	35	101	108
TOTAL	12798	14706	15287	14601	15311	16708	15962	15160	14677	19604	18888	17871

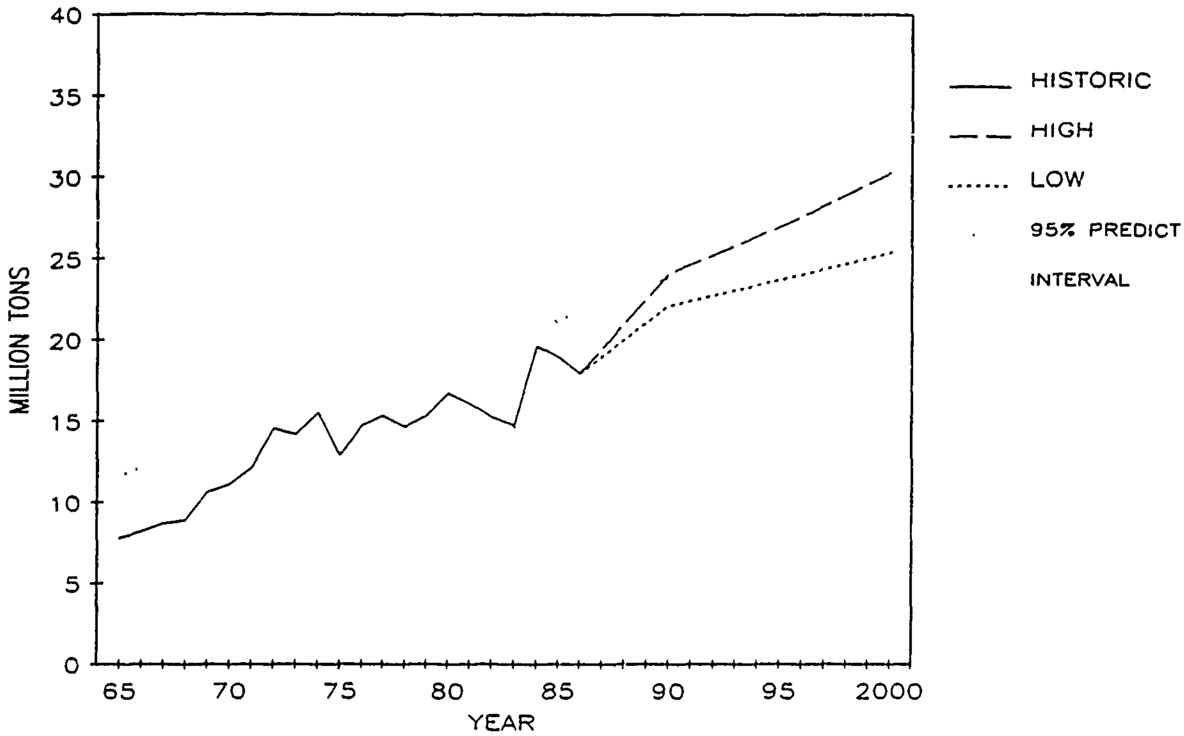
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-7-2
SEGMENT NUMBER 7
BLACK WARRIOR-TOMBIGBEE WATERWAY TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-7-3
SEGMENT NUMBER 7
BLACK WARRIOR/TOMBIGBEE WW TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-7-4
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
-------------	-----	-------	-----	-----	-----	----	----	-----	-----	-----	----	----	----	----	----	----	----	----
Bankhead	9.0	N.A.	11.7	N.A.	N.A.	N.A.	N.A.	0.7	N.A.	N.A.	N.A.	N.A.	3.9	N.A.	N.A.	5	N.A.	N.A.
Holt	11.6	N.A.	15.6	N.A.	N.A.	N.A.	N.A.	0.9	N.A.	N.A.	N.A.	N.A.	4.5	N.A.	N.A.	5	N.A.	N.A.
Wm. Bacon Oliver	12.0	N.A.	15.9	N.A.	N.A.	N.A.	N.A.	0.9	N.A.	N.A.	N.A.	N.A.	3.9	N.A.	N.A.	5	N.A.	N.A.
Seldon (Warrior)	12.0	N.A.	16.6	N.A.	N.A.	N.A.	N.A.	0.9	N.A.	N.A.	N.A.	N.A.	4.0	N.A.	N.A.	5	N.A.	N.A.
Demopolis	11.1	N.A.	16.0	N.A.	N.A.	N.A.	N.A.	1.0	N.A.	N.A.	N.A.	N.A.	3.9	N.A.	N.A.	5	N.A.	N.A.
Coffeeville	11.6	N.A.	16.2	N.A.	N.A.	N.A.	N.A.	1.0	N.A.	N.A.	N.A.	N.A.	3.8	N.A.	N.A.	4	N.A.	N.A.
Claiborne	0.7	N.A.	1.6	N.A.	N.A.	N.A.	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	2.3	N.A.	N.A.	3	N.A.	N.A.
Millers Ferry	0.4	N.A.	1.3	N.A.	N.A.	N.A.	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	2.1	N.A.	N.A.	4	N.A.	N.A.
Robert F. Henry	0.0	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	1.0	N.A.	N.A.	1	N.A.	N.A.
Gainesville	0.0	N.A.	0.3	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	1.9	N.A.	N.A.	3	N.A.	N.A.
Aliceville	0.0	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	1.5	N.A.	N.A.	2	N.A.	N.A.
Columbus	0.0	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	0.8	N.A.	N.A.	2	N.A.	N.A.
Aberdeen	0.0	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	N.A.	N.A.	0.0	N.A.	N.A.	2	N.A.	N.A.
A	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
B	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
C	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
D	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
E	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bay Springs	0.0	N.A.	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = NOT AVAILABLE
SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-7-5

SEGMENT NUMBER 7

MOBILE RIVER AND TRIBUTARIES

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1986 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MOBILE										
Ala/Coos R	3,016	3,957	3,870	4,008	3,944	4,484	3,619	5,194	5,214	4,320
B War/Tomb	4,521	5,025	8,711	11,462	9,324	8,853	11,108	15,745	12,559	8,442
Tenn-Tomb	0	208	181	1,962	2,446	2,846	4,293	5,559	8,114	10,556
Subtotal	7,537	9,190	12,762	17,432	15,714	16,183	19,020	26,498	25,887	25,309

TON MILES OF TRAFFIC (000) CY 1977-1986

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MOBILE										
Ala/Coos R	138,770	163,980	230,942	153,278	206,736	257,621	174,906	461,678	512,655	664,697
B War/Tomb	4,531,485	3,971,917	4,403,501	5,175,059	4,962,101	4,482,844	4,397,625	5,730,438	5,376,694	4,687,156
Tenn-Tomb	838	881	1,877	1,962	802	853	4,395	6,502	217,743	394,395
Subtotal	4,671,093	4,136,778	4,636,320	5,330,299	5,169,639	4,741,318	4,576,926	6,198,618	6,107,092	5,746,248

O&M COSTS PER TON MILE ($) 1977-1986

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
MOBILE										
Ala/Coos R	0.0217	0.0241	0.0168	0.0261	0.0191	0.0174	0.0207	0.0113	0.0102	0.0065
B War/Tomb	0.0010	0.0013	0.0020	0.0022	0.0019	0.0020	0.0025	0.0027	0.0023	0.0018
Tenn-Tomb	0.0000	0.2361	0.0964	1.0000	3.0499	3.3365	0.9768	0.8550	0.0373	0.0268
Segment	0.0016	0.0022	0.0028	0.0033	0.0030	0.0034	0.0042	0.0043	0.0042	0.0041

NOTE: FY 1987 costs in order by the waterway(s) above are 5,520, 13,185, and 15,080, respectively, and the subtotal is 33,785.
1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.
SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-7-6
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
BLACK WARRIOR RIVER								
Oliver	CCF	1987	1992	121,000	60,500	40,161	33	31,000
Bankhead	RC	1966	1980	47,300	0	47,300	100	0
TOMBIGBEE RIVER								
Coffeeville	SC	Unk	1985	Unk	0	Unk	100	0
Demopolis	SC	Unk	1985	Unk	0	Unk	100	0
COOSA RIVER, MONTGOMERY TO GADSDEN (NON FUEL TAXED WATERWAY)								
Walter Bouldin	SCF	1977	Unk	25,300 (1)	0	22,800 (1)	90 (1)	0 (1)
	CANS	Unk	Unk	1,359,000 (1)	0	0 (1)	0 (1)	0 (1)
Mitchell	SCF	1977	Unk	- (1)	0	- (1)	- (1)	- (1)
	CANS	Unk	Unk	- (1)	0	- (1)	- (1)	- (1)
Lay	SCF	1977	Unk	- (1)	0	- (1)	- (1)	- (1)
	CANS	Unk	Unk	- (1)	0	- (1)	- (1)	- (1)
Logan Martin	SCF	1977	Unk	- (1)	0	- (1)	- (1)	- (1)
	CANS	Unk	Unk	- (1)	0	- (1)	- (1)	- (1)
H. Neely Henry	SCF	1977	Unk	- (1)	0	- (1)	- (1)	- (1)
	CANS	Unk	Unk	- (1)	0	- (1)	- (1)	- (1)
COSSA RIVER, GADSDEN TO ROME, GA (NON FUEL TAXED WATERWAY)								
Weiss	SCNF	1977	Unk	- (1)	0	- (1)	- (1)	- (1)
	CANS	Unk	Unk	- (1)	0	- (1)	- (1)	- (1)

(1) Total amounts for the waterway.
SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sourres and explanation of status codes.

TABLE A-7-7
SEGMENT NUMBER 7
MOBILE RIVER AND TRIBUTARIES

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Bankhead	1975	32	39	9.0	11.7	N.A.	N.A.	30.0	N.A.	N.A.	N.A.	N.A.	N.A.
Holt	1966	31	36	11.6	15.6	N.A.	N.A.	34.0	N.A.	N.A.	N.A.	N.A.	N.A.
William Bacon	1939	22	24	12.0	15.9	N.A.	N.A.	33.0	N.A.	N.A.	N.A.	N.A.	N.A.
Selden (Warrior)	1957	31	39	12.0	16.6	N.A.	N.A.	38.0	N.A.	N.A.	N.A.	N.A.	N.A.
Demopolis	1954	45	54	11.1	16.0	N.A.	N.A.	44.0	N.A.	N.A.	N.A.	N.A.	N.A.
Coffeeville	1960	45	54	11.6	16.2	N.A.	N.A.	40.0	N.A.	N.A.	N.A.	N.A.	N.A.
Claiborne	1973	35	39	0.7	1.6	N.A.	N.A.	12.0	N.A.	N.A.	N.A.	N.A.	N.A.
Millers Ferry	1969	35	41	0.4	1.3	N.A.	N.A.	208.0	N.A.	N.A.	N.A.	N.A.	N.A.
Robert F. Henry	1974	33	35	0.0	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Gainesville	1978	63	64	0.0	0.3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Aliceville	1979	63	64	0.0	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Columbus	1980	63	64	0.0	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Aberdeen	1986	63	64	0.0	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
A	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
B	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
C	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
D	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
E	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bay springs	1986	63	64	0.0	0.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-8-1). The Atlantic Intracoastal Waterway consists of the 833 mile long Atlantic Intracoastal Waterway from Norfolk to the St. Johns River, about 20 miles east of Jacksonville, Florida, and the 370 mile long Intracoastal Waterway from Jacksonville to Miami. The AIWW includes the 62 mile long Albemarle and Chesapeake Canal Route and the 65 mile long Dismal Swamp Route. The Dismal Swamp Canal has virtually no commercial traffic. The main channel, 739 miles on the AIWW and 349 miles on the IWW, accounts for about 90 percent of the total length of 1,203 miles. The project depths are 12 feet in the main channel, except for 6 feet in the Dismal Swamp Canal itself and 9 to 10 feet on the rest of the Route. The project widths are 90 feet on the AIWW main channel and 125 feet on the IWW main channel, except for 50 to 100 feet on the Dismal Swamp Canal Route and 125 to 300 in some river and open water portions of the AIWW. Side channels and basins have 60 to 180 feet or unspecified project widths. The segment connects with four non fuel taxed waterways and twelve harbors with about 250,000 tons or more of traffic. One of the non fuel taxed waterways is the Okeechokee Waterway which connects the Atlantic and Gulf sections of the Intracoastal Waterway, (see Segment 6 for a description).

b. Locks (Table A-8-1). There are only three locks (two in Virginia and one in North Carolina) on the segment. But there are 13 locks on connecting waterways. The primary Great Bridge Lock is 600 feet long and 75 feet wide and the other two are 300 by 52 feet. Lifts are twelve feet or less. Great Bridge Lock is 56 years old and the other two are 47 to 48 years old.

2. PERFORMANCE CHARACTERISTICS (Table A-8-2).

Total average processing time for 1987 ranged from 23 minutes to 32 minutes. The median value is 28 minutes and Great Bridge fell below this value and South Mills fell above this value. The total average processing time increases for this segment as you move down the waterway. The total peak average processing time from 1980-1987 ranged from 24 minutes in 1983 to 47 minutes in 1984. For the 1980-1987 time period, South Mills had the highest total peak average processing time of 47 minutes in 1984 for this waterway. Total delay for 1987 ranged from 0 to 60 hours. The median value is 1 hour but Great Bridge had by far the highest delay (60 hours) when compared to the other two locks. Total delay decreases considerably as you move down the river. The peak total delay ranged from 3 hours (1985) to 155 hours (1985). For the 1980-1987 time period, Great Bridge had their highest peak total delay of 155 hours in 1985. Lock utilization for 1987 ranged from 19% to 28%. The median lock utilization value is 25% and South Mills fell below this value and Deep Creek fell above this value. The peak utilization rate for 1980-1987 ranged from 30% (1986) to 68% (1986). All the three locks had the highest peak utilization rates in 1986. From 1980 to 1987, the highest peak utilization rate occurred at South Mill in 1986 (68%). All the locks had no downtime hours for this waterway in 1987. The total peak downtime hours from 1980 through 1987 ranged from 0 hours to 12 hours (1983). Out of the three locks in this waterway, Great Bridge was the only lock that reported any downtime (12 hours in 1983), for the 1980-1987 time period. The total number

of stall events in 1987 was zero for all the locks in this segment. The total peak number of stall events for the 1980-1987 time period ranged from 0 to 4 hours (1983). Great Bridge was the only lock to have stall events in this waterway from 1980 through 1987 (4 hours in 1983).

3. COMMODITY TRAFFIC (Tables A-2, A-8-3A,-4); (Figure A-8-2,-3).

a. Historical. Traffic on the Atlantic Intracoastal Waterway between Norfolk, Virginia, and the St. John's River at Jacksonville, Florida, has fluctuated widely between about 3 and 5 million tons per year between 1965 and 1986. Tonnage peaked in 1978 and 1979 at just over 5 million tons each year before declining to 3.1 million by 1982. Commerce rebounded somewhat in 1983, declined to 3.1 million 1985, then recovered to nearly 4.4 million tons in 1986. The dominant commodity groups include agricultural chemicals and non-metallic minerals and products, with smaller amounts of petroleum products and industrial chemicals. Agricultural chemicals tonnage, predominantly phosphate rock movements from Aurora, NC, to Morehead City, North Carolina, grew from just over 40 thousand tons in 1975 to a record 1.3 million tons in 1986. Likewise, non metallic minerals, grew significantly from 174 thousand tons in 1975 to a peak of nearly 1.3 million tons also in 1986. Even as these two commodity groups were growing in tonnage, the overall decline in petroleum products traffic kept the total volume for the waterway in a general decline as well, despite an occasional upturn from one year to the next. Petroleum products traffic, which accounted for 1.7 million tons in 1978 (38 percent of the total that year) declined to a decade low of less than 500 thousand tons by 1982. Tonnage rebounded somewhat since 1983 and reached 742 thousand tons in 1986. Other important commodity groups include forest products (lumber, wood products and pulp) and metallic products and scrap; however, forest products traffic has continued a steady decline from levels of the late 1970s.

b. Forecast. Waterborne commerce on the AIWW is projected to increase between 1986 and 2000 from 4.4 million tons to between 5.7 and 8.1 million tons, primarily due to projected increases in movements of phosphate rock (agricultural chemicals) along the North Carolina stretch of the waterway for export from Morehead City. Agricultural chemicals and non-metallic minerals and products together dominate traffic and account for 60 percent of total 1986 tonnage. Non-metallic minerals and products (29 percent) and petroleum products (17 percent) are both projected to grow just slightly. Projections on the AIWW have been adjusted to take into account historically wide fluctuations in traffic from year to year.

c. Tonnages at Locks. Great Bridge Lock averaged about 0.9 million tons per year between 1982 and 1984. Traffic subsequently began to decline and fell to 0.5 million in 1987. Data for other locks are not currently available.

4. OPERATION AND MAINTENANCE COSTS (Table A-8-5).

O&M costs in actual dollars increased from about $8.6 million in 1977 to about $16 million in 1986, or about 7% increase in real terms when adjusted for about 68% inflation during the same period. On the other hand, traffic decreased from 630 million ton-miles in 1977 to 367 million ton-miles in 1986. Consequently, the O&M cost per ton-mile increased from 13 mills per ton-mile

in 1987 to 43 mills per ton-mile in 1986. This segment had the highest cost per ton-mile of all nine segments, mainly due to its low traffic level.

5. PROGRAM STATUS (Table A-8-6).

a. AIWW, Norfolk to St. Johns River. A $250,000 project review study of the Dismal Swamp Canal on the Dismal Swamp Canal route was conducted in 1985 and 1986 to consider changes in operation or disposition of the project due to marginal usage. The study recommended continued operation of the canal by the Corps if there is local cooperation or to attempt to transfer responsibility to the Department of Interior's Fish and Wildlife Service if there isn't local cooperation. The study report has been reviewed in Washington and has been reviewed at the local level. Local cooperation would involve construction of a visitor center by a local sponsor.

b. Intracoastal Waterway, Jacksonville to Miami. The study of deepening the Fort Pierce to Miami reach from ten to twelve foot, as on the Jacksonville to Fort Pierce reach, has been deferred indefinitely.

c. Cross Florida Barge Canal (Non Fuel Taxed Waterway). The Water Resources Development Act of 1986 established the Cross Florida National Conservation Area, generally consisting of canal project lands, and a Conservation Management Area, generally consisting of incomplete canal project lands. The Act also deauthorized for navigation incomplete portions of the $325 million project and mandated continued operation and maintenance of completed portions for navigation and other purposes. It further provided for the Army to acquire canal lands from the state for $32 million. The Army, the State, the U.S. Forest Service, and the U.S. Fish and Wildlife Service will coordinate and implement plans prepared by the Army and the State for environmental conservation and management of the Area. A $75,000 project review study scheduled for 1988, consisting of an evaluation of the existing project to determine the benefit-cost ratio of operating the canal in its present state of completion, has been deleted by Congress.

d. Savannah River Below Augusta (Non Fuel Taxed Waterway). The project, currently in caretaker status, is a 182 mile long, 9 by 90 foot channel from Savannah to Augusta, Georgia, with a 360 by 56 foot lock near Augusta. While in caretaker status, the operation of the lock and recreation area is being performed under contract by the City of Augusta. The gates of dams above Augusta are still being operated by the Corps of Engineers to provide for reregulated flows on the Savannah River. Following completion in 1987 of a reconnaissance study of the Savannah River Basin, a study of navigational improvements on the lower 40 miles of the Savannah River below Augusta is being initiated in FY 1988 and completed in 1989. The local sponsor will share 50 percent of the cost of the feasibility phase. The federal study cost is $0.7 million out of a total cost of $0.9 million. A separate $50,000 project review study is also scheduled in 1988 to consider disposition of the project, particularly the lock, due to marginal usage.

e. New Jersey Intracoastal Waterway (Non Fuel Taxed Waterway). The 117 mile long project extends from the Atlantic Ocean at Manasquan Inlet, about 26 miles south of Sandy Hook, NJ, to Delaware Bay about 3 miles above Cape May. The 1945 authorization provided for a channel 12 feet deep and 100 feet wide,

but the $7.4 million (1954 estimate) project is only about 25 percent complete and is generally maintained at a 6 foot depth. Annual traffic is about 120,000 tons of cargo and 1.2 million passengers, predominantly in Cape May County. A reconnaissance study of improvements, including possible completion of the project, was completed in 1988, but it did not recommend deepening the waterway. The subsequent feasibility study of depths up to 15 in the Cape May area for fishing vessels is being initiated in FY 1988 and completed in 1989. The total cost is $0.5 million with the feasibility phase being cost shared on a 50-50 percent basis by Federal and non-Federal interests. This study incorporates to planning, engineering, and design (PED) authorized in 1986 for the 20 to 25 foot deep Cold Spring Inlet (Cape Map Inlet) and the waterway. Both the feasibility study and the authorized PED are related to the approved navigation /shore protection plan that would modify Cape May Inlet for $17.3 million. For this project the Phase I General Design Memorandum (GDM) was authorized in 1976, conducted in 1977-80, approved by the Chief of Engineers in 1981, and followed by completion of the Phase II GDM in 1983.

f. Intracoastal Waterway, Miami to Key West (Non Fuel Taxed Waterway). The project was constructed in 1939, about 63 miles to Cross Bank in the Florida Keys, and the remaining portion to Key West was deauthorized by the Water Resources Development Act of 1986, PL 99-662.

6. LOCK CAPACITY CHARACTERISTICS (Table A-8-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-8-4.

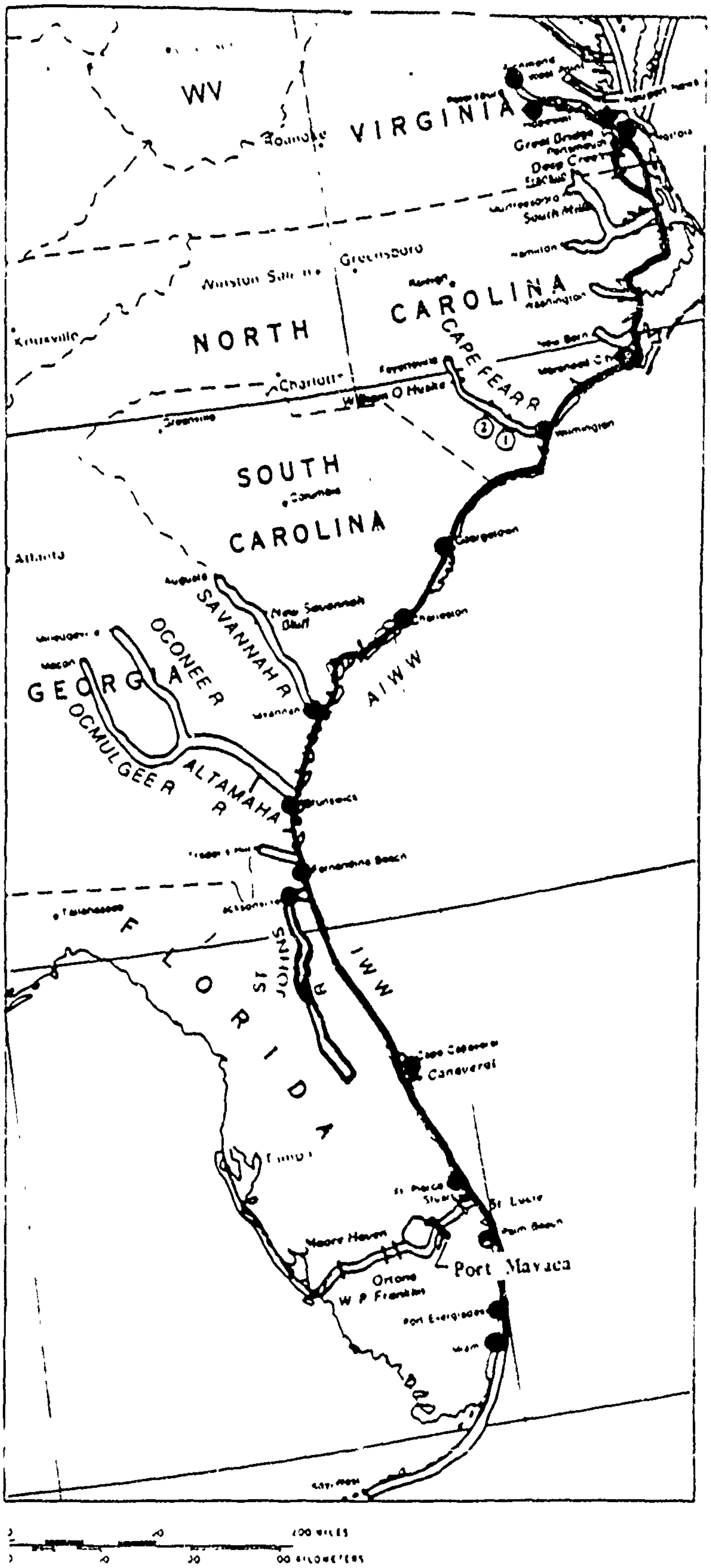


Figure A-8-1
Segment 8, AIWW

TABLE A-8-1
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Albemarle and Chesapeake Canal Route						
Great Bridge	11.5	1932	56	75	600	3
Dismal Swamp Canal Route						
South Mills	33.2	1941	47	52	300	12
Deep Creek	10.6	1940	48	52	300	12

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

TABLE A-8-2

SEGMENT NUMBER 8

ATLANTIC INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)*	AVERAGE PROCESSING TIME PER TOW: DELAY** (MIN) PEAK*	DELAY** (MIN) 1987	LOCKAGE** (MIN) PEAK*	LOCKAGE** (MIN) 1987	TOTAL** (MIN) PEAK*	TOTAL** (MIN) 1987	TOTAL DELAY** (HOURS) PEAK*	TOTAL DELAY** (HOURS) 1987	LOCK** UTILIZATION PERCENTAGE PEAK*	LOCK** UTILIZATION PERCENTAGE 1987
Great Bridge	5 (83)	4	20 (82)	19	24 (83)	23	155 (83)	60	30 (86)	25
South Mills	26 (84)	7	26 (80)	25	47 (84)	32	3 (85)	1	68 (86)	19
Deep Creek	8 (82)	4	29 (80)	24	34 (80)	28	10 (81)	0***	54 (86)	28

* Peak represents the highest value from 1980 through 1987, with the ~~year of~~ occurrence in parenthesis.

** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls

** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls

** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl

** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)

** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year

*** Zero indicates that no data is available

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-8-2
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL NO. OF STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Great Bridge	12 (87)	0**	0	0	1 (82)	0	12 (83)	0	4 (83)	0	0	0	2 (82)	0	4 (83)	0
South Mills	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deep Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.

** Zero indicates no data is available.

*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

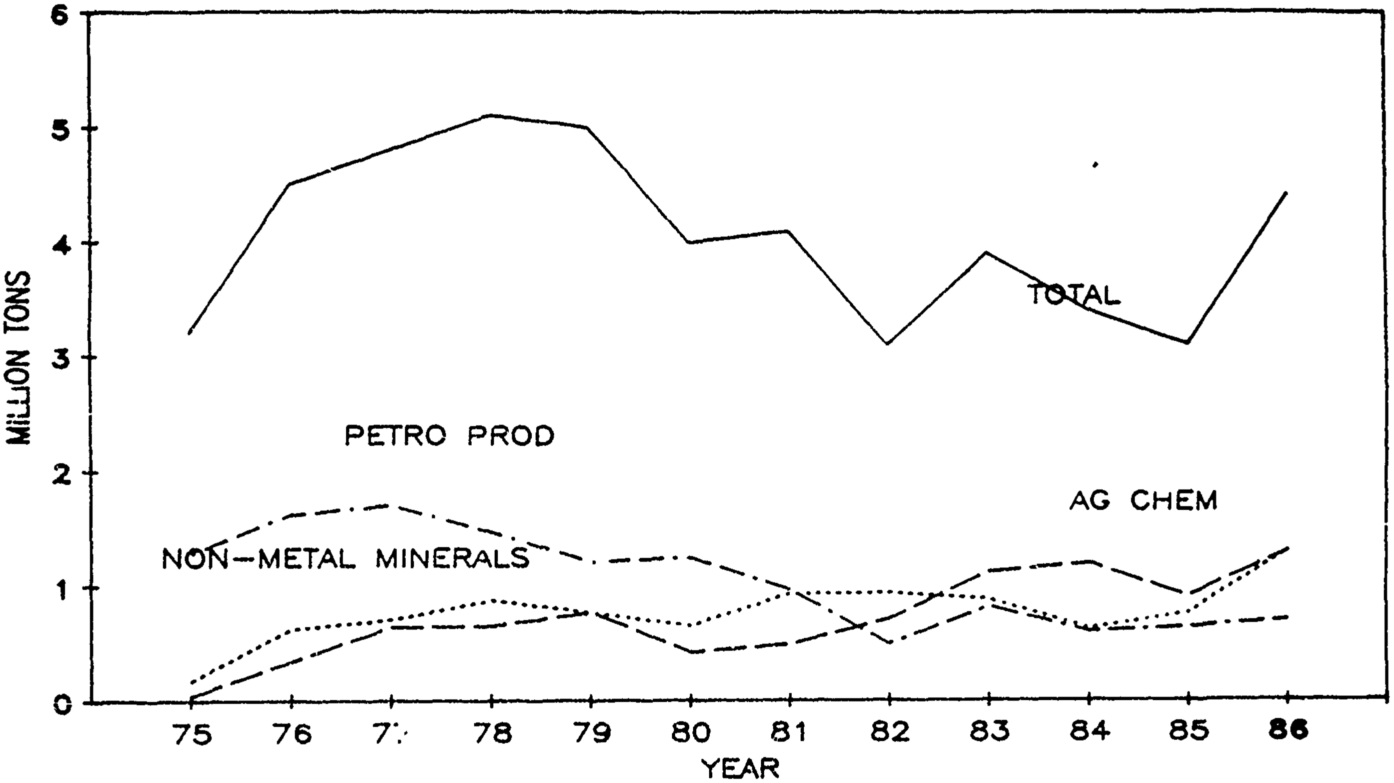
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-8-3
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	124	187	109	173	187	156	215	164	93	151	128	102
Other Agricultural Prdcts	25	39	61	67	45	45	44	45	55	11	9	13
Metallic Ores	404	281	503	603	764	365	322	11	0	34	39	4
Coal	0	0	0	0	0	0	0	0	0	0	0	0
Crude Petroleum	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metlc Minerals & Prod	174	618	708	872	763	647	929	941	885	624	765	1283
Lumber, Wood Prod. & Pulp	832	881	704	855	827	680	544	301	343	336	252	236
Industrial Chemicals	62	74	70	89	62	95	211	92	130	161	136	354
Agricultural Chemicals	43	343	638	645	773	416	491	707	1118	1198	907	1348
Petroleum Prdcts	1281	1616	1699	1471	1212	1247	969	491	816	600	643	742
Metallic Products & Scrap	143	130	146	122	187	140	178	187	247	193	209	226
All Other Commodities	117	285	119	175	201	175	181	203	176	69	54	75
TOTAL	3205	4454	4757	5072	5021	3966	4084	3142	3863	3377	3142	4383

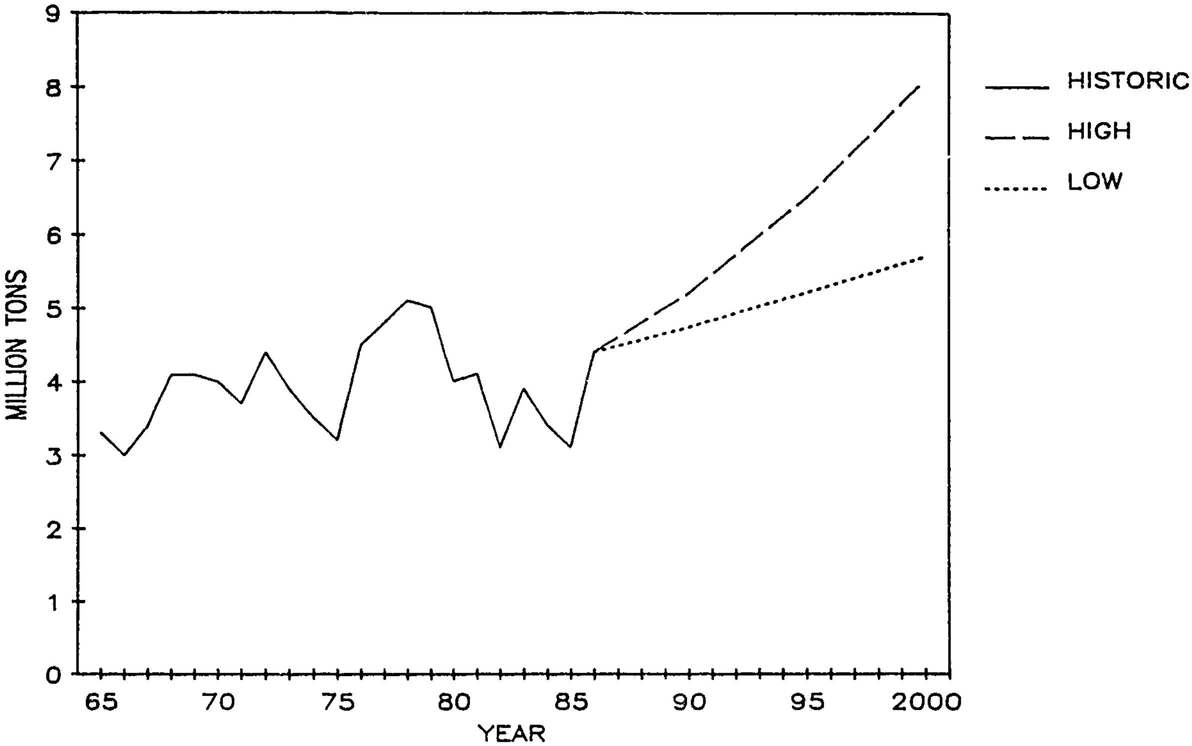
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-8-2
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WW TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-8-3
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WW TRAFFIC
HISTORIC 1965-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-8-4
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

WATERWAY/LOCK NAME OR NUMBER	TONS (Millions) 1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	NUMBER OF TOWS (Thousands) 1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	AVG TONS/TOW (Thousands) 1985	1986	1987	AVG.NO.OF BARGES/TOW 1985	1986	1987
Great Bridge	N.A.	N.A.	0.8	0.7	0.5	0.3	0.2	1.3	1.3	0.0	0.0	0.0	0.6	0.6	0.1	1.0	1.0	1.0
South Mills	N.A.	N.A.	0.0	0.5	0.0	0.0	0.0	2.0	3.0	0.0	0.0	0.0	0.0	0.2	0.0	1.0	1.0	1.0
Deep Creek	N.A.	N.A.	NEG	0.3	0.0	0.0	0.0	11.0	6.0	0.0	0.0	0.0	0.4	0.5	0.0	1.0	1.0	1.0

N.A. = NOT APPLICABLE
NEG = NEGLIGIBLE
SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-8-5
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AIWW/IWW										
AIWW/IWW	8,559	12,725	11,697	9,539	11,181	7,870	12,316	10,760	12,908	15,803
Subtotal	8,559	12,725	11,697	9,539	11,181	7,870	12,316	10,760	12,908	15,803
TON MILES OF TRAFFIC (000) CY 1977-1986										
AIWW/IWW										
AIWW/IWW	630,605	575,718	622,853	483,313	517,757	376,433	455,999	368,936	346,244	367,098
Subtotal	630,605	575,718	622,853	483,313	517,757	376,433	455,999	368,936	346,244	367,098
O & M COSTS PER TON MILE ($) 1977-1986										
AIWW/IWW										
AIWW/IWW	0.0136	0.0221	0.0188	0.0197	0.0216	0.0209	0.0270	0.0292	0.0373	0.0430
Segment	0.0136	0.0221	0.0188	0.0197	0.0216	0.0209	0.0270	0.0292	0.0373	0.0430

NOTE: FY 1987 costs in order by the waterway(s) above are 16,563 and subtotal is 16,563.
1987 Cost/Ton-Mile is not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-8-6
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
ATLANTIC INTRACOASTAL WATERWAY, NORFOLK TO ST. JOHNS RIVER								
Dismal Swamp Canal	SC	1985	1986	250	0	0	100	0
INTRACOASTAL WATERWAY, JACKSONVILLE TO MIAMI								
Ft. Pierce-Miami Channel	SANS	Unk	Unk	Unk	0	Unk	Unk	0
CROSS FLORIDA BARGE CANAL (NON FUEL TAXED WATERWAY)								
Envr. Cons. Mngt. Plan	SANS	Unk	Unk	Unk	0	0	0	0
Eureka	SANS	1988	1988	75	0	0 (2)	0 (2)	0 (2)
	CCNF (1)	1964	1986	325,000	0	75,000 (2)	36 (2)	0 (2)
Inglis	SANS	1988	1988	- (2)	0	- (2)	- (2)	- (2)
	CCNF (1)	1964	1971	Unk	0	- (2)	- (2)	- (2)
Henry H. Buckman	SANS	1988	1988	- (2)	0	- (2)	- (2)	- (2)
	CCNF (1)	1964	1972	Unk	0	- (2)	- (2)	- (2)
SAVANNAH RIVER (NON FUEL TAXED WATERWAY)								
New Savannah Bluff	SAS	1988	1988	0	0	50	0	50
Lower Savannah River	SCF	1986	1989	920	0	600	65	160

TABLE A-8-6(continued)
SEGMENT NUMBER 8
ATLANTIC INTRACOASTAL WATERWAY

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
INTRACOASTAL WATERWAY, MIAMI TO KEY WEST (NON FUEL TAXED WATERWAY)								
Channel	CCNF(3)	Unk	Unk	Unk	0	Unk	Unk	0
	SANS	Unk	Unk	Unk	0	Unk	Unk	0
New Jersey IWW								
(Non Fuel Taxed Waterway)	SCF	1987	1989	545	0	295	54	125

(1) Remainder of project deauthorized in 1986. Three locks are operational; two were not started.
(2) Total amounts are for the waterway.
(3) Constructed 63 miles to Cross Bank in 1939; remainder deauthorized in 1986.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-8-7

SEGMENT NUMBER 8

ATLANTIC INTRACOASTAL WATERWAY

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3 (1987)
Great Bridge	1932			N.A.	0.8	0.7	0.5	N.A.	N.A.	N.A.	N.A.	N.A.	25
South Mills	1941			N.A.	0.0	0.5	0.0	N.A.	N.A.	N.A.	N.A.	N.A.	19
Deep Creek	1940			N.A.	NEG	0.3	0.0	N.A.	N.A.	N.A.	N.A.	N.A.	28

(1) 1987 tonnage divided by Low capacity value (column 3)
(2) 1987 tonnage divided by High capacity value (column 4)
(3) Performance Monitoring System, Corps of Engineers, 1987

SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

1. PHYSICAL CHARACTERISTICS.

a. Channels (Figure A-9-1). This segment includes the Columbia River from Bonneville Lock and Dam (mile 146) to the tri-cities of Pasco, Kennewick, and Richland, Washington, (mile 338) just above its junction with the Snake River; the Snake River from its junction with the Columbia River to Johnson's Bar Landing, Idaho (mile 233), 92 miles above Lewiston, Idaho (mile 141); and the Willamette River above Portland (mile 14) to Corvallis (mile 132) and the Yamhill River to mile 7. The Columbia River channel from Bonneville Lock and Dam to The Dalles Lock and Dam (mile 190) is actually excluded from those waterways whose traffic is subject to the inland waterways fuel tax, but is included here because the lock and channel are the gateway to the Columbia-Snake waterway system. The Columbia River project depth is 27 feet from Bonneville Lock and Dam to The Dalles Lock and Dam, 15 feet from The Dalles Lock and Dam to McNary Lock and Dam, and 14 feet to Richland. The project width on the Columbia River is 300 feet below The Dalles Lock and Dam and 250 feet above it. The project dimensions on the Snake river are 14 feet deep and 250 feet wide to Lewiston and two feet deep thereafter. The Willamette River is maintained at 8 feet to the locks at Oregon City (mile 26) and widths of 200 feet to Cedar Island (mile 23) and 150 feet from there to Oregon City. Above Oregon City the maintained dimensions are 3.5 feet or less deep and 150 feet wide.

b. Locks (Table A-9-1). On the Columbia-Snake waterway the locks are 675 feet long and 86 feet wide, except for Bonneville Lock and Dam, which is only 500 feet long and 76 feet wide. The eight locks and dams have lifts of 59 to 105 feet for an average lift of 90 feet and a total lift of 723 feet. The locks are 13 to 35 years old, except for the 50 year old Bonneville Lock and Dam. On the Willamette River there are 5 locks at Willamette Falls (Oregon City) that are 115 years old, but no dam. They are 210 feet long and 40 feet wide, and have a total lift of 60 feet with individual lifts being 10 to 20 feet.

2. PERFORMANCE CHARACTERISTICS (Table A-9-2).

The total average processing time for 1987 ranged from 34 minutes to 1174 minutes or 19.57 hours. Four locks (McNary, Ice Harbor, Little Goose and Lower Granite) had an average processing below the system's median value of 49.5 minutes. The total peak average processing time for 1980-1987, ranged from 73 minutes (1980) at McNary lock to 1174 minutes (1984) at Locks 1-4. The highest total peak average processing time for the 1980-1987 time period occurred at Locks 1-4 in 1987 (1174 minutes or 19.57 hours). Total delay for 1987, ranged from 59 hours to 8,721 hours. The median total delay value was 225 hours, and two locks (Bonneville and Locks 1-4) had delays far in excess of the median. Total delay time increases as you move downstream from Lower Granite to Bonneville. The peak total delay from 1980-1987 varied anywhere from 854 hours (1981) at Lower Granite to 8,724 hours (1987) at Locks 1-4. The highest peak total delay for 1980-1987 occurred in 1987 at Locks 1-4 (8,721 hours). Lock utilization for 1987 ranged from 8% to 53%. The median utilization value is 15%. Most of the locks were concentrated around this rate except for Bonneville and Locks 1-4, which had rates in excess of other

locks. The peak utilization for the 1980-1987 time period ranged from 21% (1986) at Lower Granite to 69% (1981) at Bonneville. The highest peak utilization rate for 1980-1987 occurred in 1981 at Bonneville (69%). The total downtime in 1987, ranged from 0 hours to 374 hours. Locks McNary through Lower Granite experienced by far more downtime then the rest of the lock in this waterway. The median total downtime value is 131 hours and five locks on the lower part of the river (Bonneville, The Dalles, John Day, Locks 1-4 and Guard Lock) had downtime hours considerably below this median value. The total peak downtime in this waterway ranged from 0 hours at Locks 1-4 to 1841 hours (1980) at Ice Harbor. The highest total peak downtime for the 1980-1987 time period occurred in 1980 at Ice Harbor (1841 hours). Total stall events for 1987, ranged from 0 to 47. The median stall event value is 7, and four locks (Bonneville, The Dalles, McNary and Ice Harbor)had stall events above the median value. The total peak stall events for the 1980-1987 time period ranged from 0 at Locks 1-4 to 127 (1981) at Ice Harbor. The highest total peak stall events for 1980-1987 occurred in 1981 at Ice Harbor (127 stall events).

3. COMMODITY TRAFFIC (Tables A-2, A-9-3A,-4); (Figure A-9-2,-3).

a. Historical. Waterborne commerce on the Columbia River and its tributaries, the Snake and Willamette rivers, has varied considerably over the past decade depending upon economic conditions of the Pacific Northwest and the demand for U.S. grain and forest product exports. Internal traffic (non-oceangoing) on the Columbia averaged about 16.7 million tons annually between 1975 and 1986. Total traffic peaked in 1987 and 1980 at just over 19 million tons, while 1985 saw a low for the period of 14 million tons, due primarily to the decline of grain exports. Tonnage on the Snake River averaged 3.2 million annually between 1975 and 1979, and 5.4 million annually between 1980 and 1986. Forest products (lumber, wood products and pulp) is the dominant commodity group on the Columbia, followed by grains and oilseeds. On the Snake, grain is dominant (primarily wheat). Forest products movements on the Columbia peaked in 1976 at 10.6 million tons, then generally declined to a low of 5.8 million tons in 1982. Traffic has rebounded somewhat since then with improved economic conditions for the industry, and movements in 1986 amounted to about 6.6 million tons. Grain and oilseed movements on the Columbia generally grew after 1975 to a peak of 6.2 million tons in 1982 as exports to Pacific Rim markets increased in importance. The strength of the dollar and competition from Canada and Australia ultimately eroded this export market and grain traffic declined to 3.7 million tons in 1985 and 3.8 million tons in 1986. Other important commodity groups moving on the Columbia include petroleum products (2.0 million tons in 1986) and non-metallic minerals and products (1.2 million tons in 1986). Traffic at individual locks on the Columbia-Snake system increased from 4 to 22 percent between 1986 and 1987, indicating a rebound in total waterway traffic. The falling value of the dollar and grain export subsidies led to increased traffic in farm and forest products in 1987.

b. Forecast. Between 1986 and 2000, waterborne traffic on the Columbia River is projected to grow, from 14.1 million tons to between 17.3 and 24.7 million tons. The decline on the Columbia is due principally to a significant drop in traffic from 1984 to 1985 with the collapse of the grain export market, and the longer term decline in forest products movements from levels

of the 1970s. Both of these declines are being reversed as the decline in the value of the dollar and agricultural policies make U.S. forest and farm products more competitive overseas. Accounting for 47 percent of all traffic in 1986, forest products make up the major commodity group influencing future traffic forecasts. Recovery of the lumber industry from the low traffic levels of 1986 is expected; however, forest products tonnage on the Columbia River are expected to fluctuate with swings in the construction industry cycle and the value of the dollar. The projection envelope has been adjusted to account for these wide fluctuations. Of the other important commodities moved on the Columbia River, farm products (27 percent of traffic) are also projected to increase, while petroleum products (14 percent) are projected to exhibit very slow growth.

c. Tonnages at Locks. Based on average annual percent change during 1977-1987 period, tonnage increase ranged from 4.8% (The Dalles) to 2.6% (Little Goose). One lock showed a decline in average annual percentage change of -0.9% (Lower Granite). Actual tonnage changes to 1987 since 1977 range from -0.2 million tons (Lower Granite) to 3.1 million tons (Bonneville). The range of total tonnage for 1987 is from 2.2 million tons (Lower Granite) to 8.9 million tons (Bonneville).

4. OPERATION AND MAINTENANCE COSTS (Table A-9-5).
O&M costs in actual dollars increased from about $3.1 million in 1977 to about $9 million in 1986 or about a 79% increase in real terms when adjusted for 68% inflation during the same period. Traffic decreased from about 1.4 billion ton-miles in 1977 to about 1.2 billion ton-miles in 1986. The O&M cost per ton-mile in 1977 was 2.2 mills and increased to 7.3 mills per ton-mile in 1986. This segment has the second highest cost per ton-mile of all nine segments.

5. PROGRAM STATUS. (Table A-9-6)
a. Bonneville Navigation Lock. The 675 foot long and 86 foot wide single chamber will replace the 49 year old, 500 by 76 foot lock that has caused increasing delays (up to 8 hours) and congestion. The problem occurs because only two barges, out of an optimum tow configuration of five barges on the river system, can be locked through at one time. The $212 million project will be completed in 1992. It is 32 percent complete in 1988 and will be 52 percent complete with funds requested for FY 1989. Work in 1988 and 1989 includes continuation of lock excavation and construction (about 75 percent of costs), channels and canals, and relocations and initiation and continuation of roads and bridges and buildings, grounds, and utilities.

b. Middle Columbia River (Non Fuel Taxed Waterway). The $21.4 million Columbia River and Tributaries basin multiple-purpose study will lead to an operational and management plan that will optimize the multiple use aspects of the system in its five state area. The $2.3 million detailed feasibility study on development of navigation in the middle Columbia River above Richland to Wenatchee continues in 1988 and will be completed with an interim report in 1989. The $110.0 million preliminary cost estimate is for construction for Mississippi River type barges of lifts at the existing Priest Rapids, Wanapum, and Rock Island Dams and dredging a nine foot channel in the Hanford reach below Priest Rapids Dam. The current estimate is about $80 million less

expensive than the initial plan because Columbia River type barges would not be used. That results in reducing the 14 foot channel, smaller lifts, and less impact on spawning areas for anadromous fish.

6. LOCK CAPACITY CHARACTERISTICS (Table A-9-7).

The source of capacity range is National Waterways Study - A Framework for Decision Making - Final Report, Appendix D, National Waterways Reach Summaries, Institute of Water Resources, January 1983. Capacity range values were again reviewed by the districts in 1987 and 1988. Historical tonnages are from lock PMS data and is also from Table A-9-4.

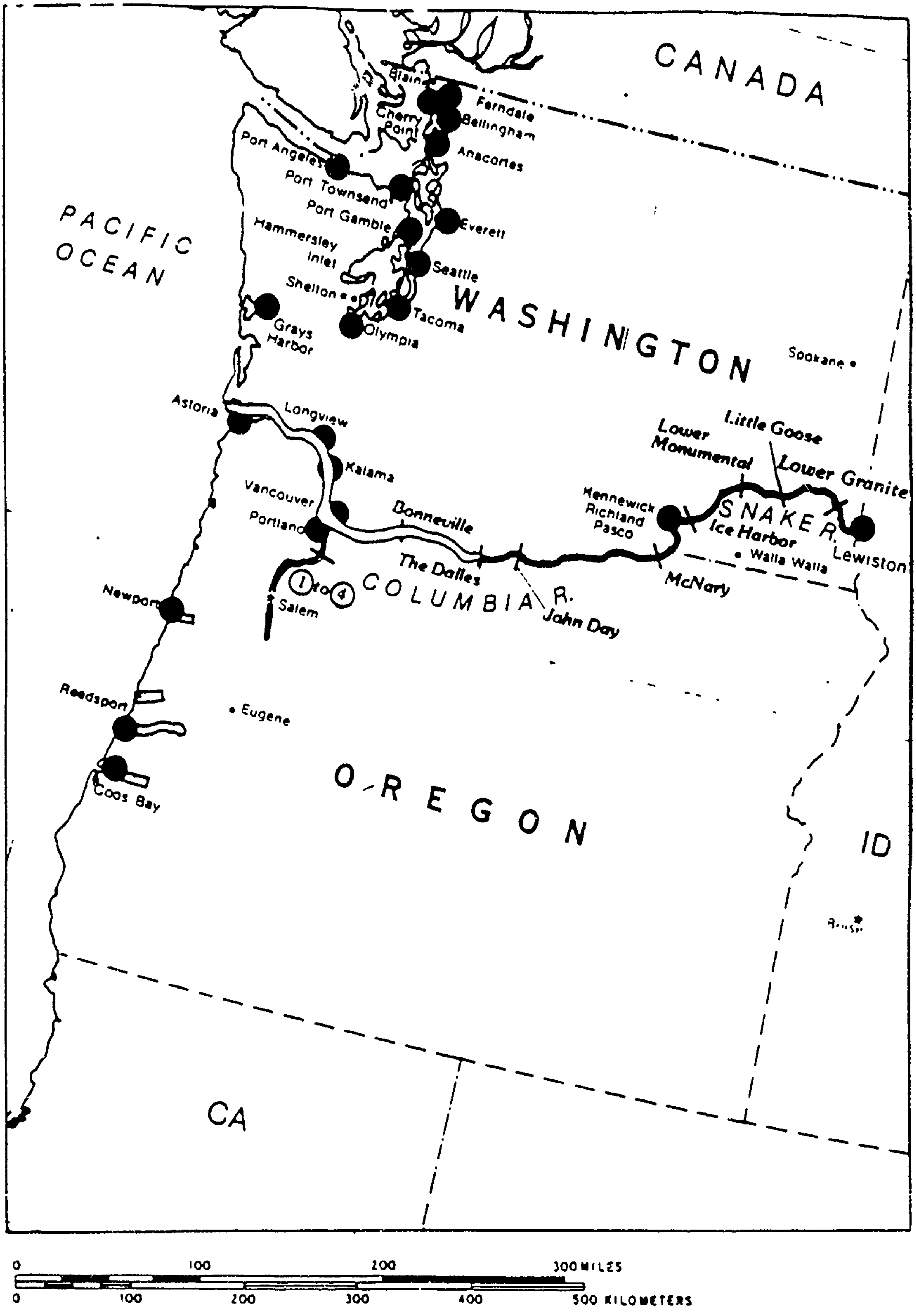


Figure A-9-1
Segment 9, Columbia-Snake

TABLE A-9-1
SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

PHYSICAL CHARACTERISTICS OF LOCKS

WATERWAY/LOCK NAME OR NUMBER	RIVER MILE	YEAR OPENED	AGE AS OF 1988	CHAMBERS WIDTH (FEET)	CHAMBERS LENGTH (FEET)	CHAMBERS LIFT (FEET)
Columbia-Snake Waterway						
Bonneville	146.0	1938	50	76	500	65
Bonneville (u const)	146.0	1992	--	86	675	65
The Dalles	190.0	1957	31	86	675	88
John Day	215.0	1968	20	86	675	110
McNary	282.0	1953	35	86	675	75
Ice Harbor	9.7	1962	26	86	675	100
Lower Monumental	41.6	1969	19	86	675	98
Little Goose	70.3	1970	18	86	675	98
Lower Granite	107.5	1975	13	86	675	100
Willamette River						
Willamette Falls Locks						
Lock No. 1	26.0	1873	115	40	210	20
Lock No. 2	26.0	1873	115	40	210	10
Lock No. 3	26.0	1873	115	40	210	10
Lock No. 4	26.0	1873	115	40	210	10
Guard Lock	26.4	1873	115	40	210	10

Source: Annual Report FY86 of the Secretary of the Army on Civil Works Activities, Volume II, Appendix C: Navigation Locks and Dams Operable September 30, 1986.

TABLE A-9-2

SEGMENT NUMBER 9

COLUMBIA-SNAKE-WILLAMETTE

PERFORMANCE CHARACTERISTICS OF LOCKS (PART A)

WATERWAY/LOCK (PEAK YEAR)	AVERAGE PROCESSING TIME PER TOW: DELAY (MIN) PEAK	DELAY (MIN) 1987	LOCKAGE (MIN) PEAK	LOCKAGE (MIN) 1987	TOTAL (MIN) PEAK	TOTAL (MIN) 1987	TOTAL DELAY (HOURS) PEAK	TOTAL DELAY (HOURS) 1987	LOCK UTILIZATION PERCENTAGE PEAK	LOCK UTILIZATION PERCENTAGE 1987
Columbia-Snake WW										
Bonneville	100 (81)	69	108 (83)	96	196 (80)	165	4744 (81)	2373	69 (81)	53
Bonneville (u. cons)										
The Dalles	62 (85)	9	45 (80)	41	102 (85)	50	1483 (85)	225	22 (86)	17
John Day	507 (80)	16	65 (80)	51	572 (80)	67	2939 (80)	394	309 (80)	21
McNary	37 (80)	6	38 (84)	36	73 (80)	42	1279 (80)	151	26 (86)	13
Ice Harbor	51 (80)	11	38 (83)	36	87 (80)	47	2117 (80)	253	29 (86)	17
Lwr. Monumental	56 (80)	8	46 (84)	41	94 (80)	49	1113 (80)	134	24 (86)	11
Little Goose	63 (80)	5	36 (83)	31	94 (80)	36	1218 (80)	76	22 (86)	8
Lower Granite	52 (81)	4	30 (87)	30	79 (81)	34	854 (81)	59	21 (86)	10
Williamette River										
Locks 1-4	DATA NOT AVAILABLE									
Guard Lock	DATA NOT AVAILABLE									

* Peak represents the highest value from 1980 through 1987, with the year of occurrence in parenthesis.

** Average Delay (hrs) (all commercial vessels) = (Wait + Stall) / # vsls

** Average Lockage Time (hrs) = App + Entry + Chbr + Exit + Trnbk / # vsls

** Average Processing Time (hrs) = Wait + App + Ent + Chbr + Exit + Trnbk + Stl / # vsl

** Total Delay Time (hrs) = Wait + Stall (commercial vsls only)

** Percent Lock Utilization = (Hrs in Year - Idle) / Hrs in Year

Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-9-2
SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

PERFORMANCE CHARACTERISTICS OF LOCKS (PART B)

WATERWAY/LOCK (PEAK YEAR)*	TOTAL DOWNTIME HOURS BY CONDITION***								TOTAL STALL EVENTS BY CONDITION***							
	LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL		LOCK CONDITIONS		NATURAL CONDITIONS		TOW & OTHER CONDITIONS		TOTAL	
	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987	PEAK*	1987
Columbia-Snake WW																
Bonneville	13 (84)	4	52 (82)	0**	17 (83)	14	77 (82)	18	6 (84)	2	2 (82)	0	14 (87)	14	16 (87)	16
Bonneville (u const)																
The Dalles	317 (86)	15	0	0	1264 (85)	4	1265 (85)	19	9 (85)	5	1 (81)	0	25 (81)	4	30 (81)	9
John Day	6 (81)	18	3 (84)	0	1398 (80)	1	1418 (80)	19	19 (81)	1	1 (84)	0	3 (84)	1	21 (81)	2
McNary	988 (80)	342	0	1	50 (80)	4	1038 (80)	347	9 (84)	6	0	1	177 (80)	28	105 (80)	35
Ice Harbor	1037 (80)	353	19 (84)	5	791 (80)	16	1841 (80)	374	29 (80)	22	6 (84)	1	358 (81)	57	127 (81)	80
Lwr Monumental	986 (80)	301	2 (87)	2	22 (84)	2	991 (80)	305	8 (86)	6	1 (87)	1	50 (84)	7	14 (86)	14
Little Goose	1011 (80)	243	3 (83)	0	758 (81)	1	1018 (80)	243	35 (80)	3	1 (83)	0	47 (81)	1	35 (80)	4
Lower Granite	346 (86)	262	0	0	779 (81)	1	781 (81)	263	36 (83)	0	1 (83)	0	43 (81)	7	40 (83)	7
Williamette R.																
Locks 1-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guard Lock	1 (80)	0	0	0	0	0	1 (80)	0	1 (85)	0	0	0	0	0	1 (80)	0

* Peak represents the highest value from 1980 through 1988, with the year of occurrence in parenthesis.
** Zero indicates that no data is available.
*** Total Downtime Hours by Condition and Total No. of Stall Events by Condition are calculated the following way:

Lock conditions = debris in lock recesses or in lock chamber + lock hardware + lock staff occupied with other duties + testing or maintaining lock or lock equipment.

Natural conditions = fog + rain + sleet or hail + snow + wind + ice + river current or outdraft + flood

Tow and Other conditions = Interference by other vessels + tow malfunction or breakdown + tow staff occupied with other duties + tow detained by Coast Guard and/or Corps + collision or accident + vehicular or railway bridge delay + other.

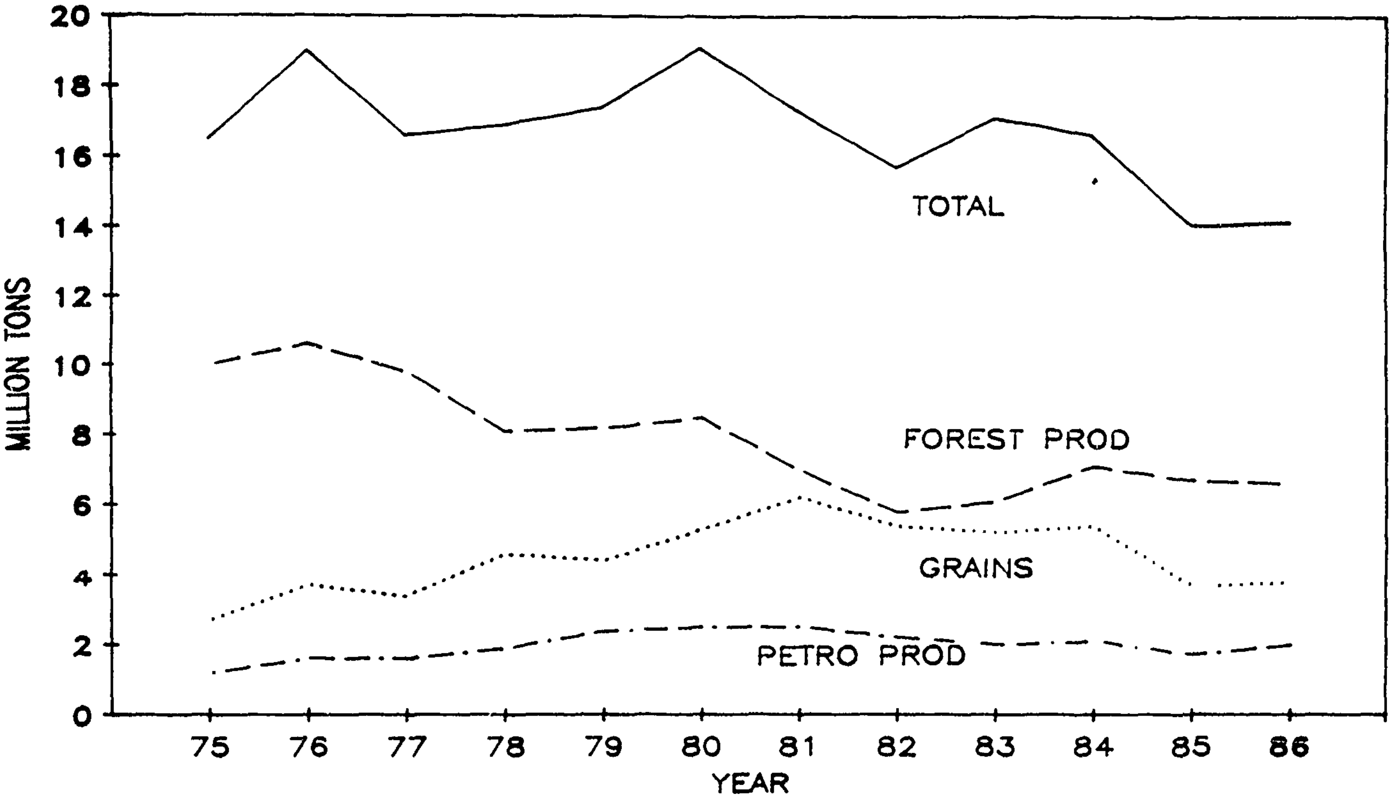
Source: Lock Performance Monitoring System (PMS), Corps of Engineers, 1988.

TABLE A-9-3
SEGMENT NUMBER 9
COLUMBIA RIVER TRAFFIC
1975-1986
(THOUSAND TONS)

COMMODITY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Grains and Oilseeds	2747	3684	3399	4629	4387	5263	6192	5448	5152	5358	3670	3824
Other Agricultural Prdcts	22	44	56	50	68	52	54	67	221	222	206	167
Metallic Ores	0	0	0	0	0	0	0	0	0	0	10	0
Coal	0	0	0	0	0	0	0	0	0	0	0	0
Crude Petroleum	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metlc Minerals & Prod	1804	1519	1549	1757	1640	1706	1047	1196	1544	576	1282	1184
Lumber, Wood Prod. & Pulp	9956	10599	9768	8100	8204	8452	6960	5814	6059	7092	6662	6624
Industrial Chemicals	192	207	148	242	227	335	144	17	6	24	110	145
Agricultural Chemicals	61	97	64	78	84	60	76	76	67	58	61	86
Petroleum Prdcts	1247	1620	1622	1946	2350	2542	2478	2206	2029	2121	1721	1959
Metallic Products & Scrap	2	33	20	26	30	1	1	2	20	5	19	3
All Other Commodities	513	1152	22	30	412	650	348	862	2022	1187	219	99
TOTAL	16544	18955	16648	16858	17402	19061	17300	15688	17120	16643	13960	14091

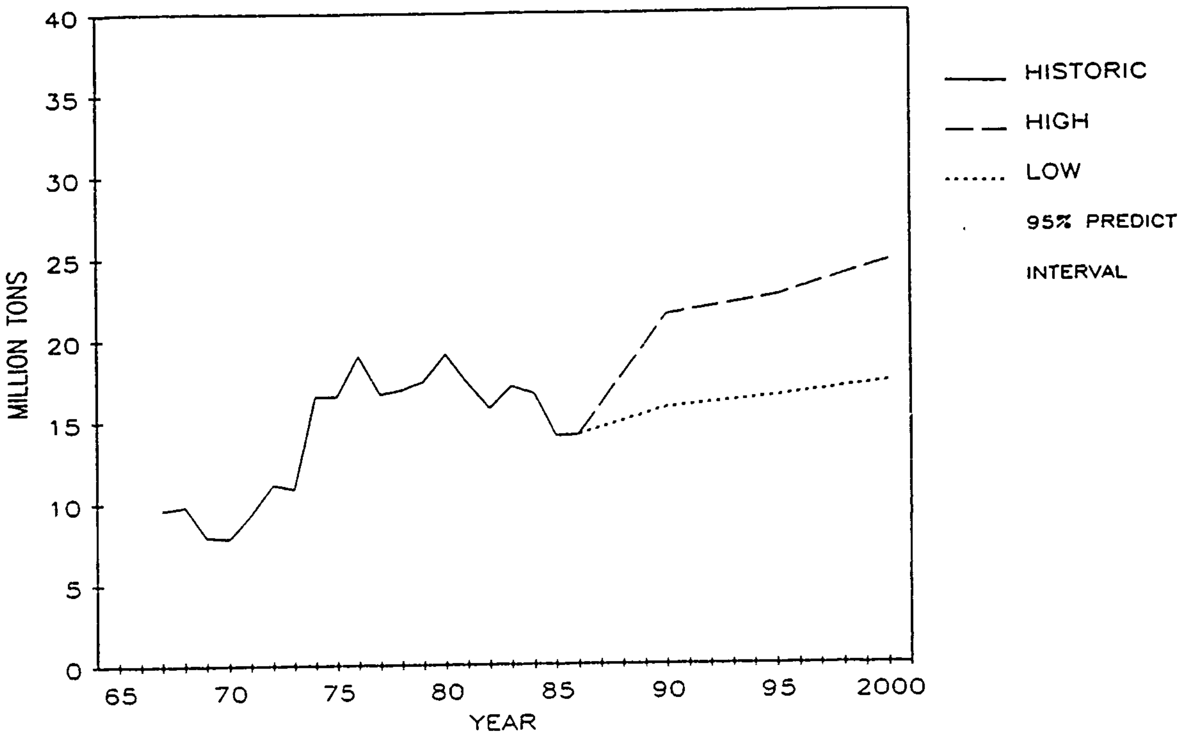
SOURCE: U.S. ARMY CORPS OF ENGINEERS, WATERBORNE COMMERCE OF THE UNITED STATES, ANNUAL.

FIGURE A-9-2
SEGMENT NUMBER 9
COLUMBIA RIVER TRAFFIC
TOTAL AND MAJOR COMMODITIES: 1975-1986



GRAPHED BY WRSC-IWR. DATA SOURCE: WATERBORNE COMMERCE, ANNUAL.

FIGURE A-9-3
SEGMENT NUMBER 9
COLUMBIA RIVER TRAFFIC
HISTORIC 1967-1986 AND PROJECTED 1990, 1995 AND 2000



GRAPHED BY IWR. HISTORIC DATA-WCSC. PROJECTIONS-VARIOUS.

TABLE A-9-4
SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

COMMODITY TRAFFIC CHARACTERISTICS AT LOCKS

	TONS (Millions)							NUMBER OF TOWS (Thousands)					AVG TONS/TOW (Thousands)			AVG.NO.OF BARGES/TOW		
WATERWAY/LOCK NAME OR NUMBER	1977 TOTAL	% AVERAGE ANNUAL CHANGE 77-87	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DNBD	1985 TOTAL	1986 TOTAL	1987 TOTAL	1987 UPBD	1987 DWBD	1985	1986	1987	1985	1986	1987
Bonneville	5.8	4.4%	7.7	8.3	8.9	N.A.	N.A.	1.7	1.8	1.3	0.4	0.9	9.6	4.7	112.2	3	3	5
The Dalles	4.7	4.8%	6.3	8.2	7.5	N.A.	N.A.	1.2	1.3	1.4	0.7	0.7	5.3	6.4	6.9	3	3	4
John Day	4.7	4.6%	6.2	7.1	7.4	N.A.	N.A.	1.2	1.3	1.4	0.7	0.7	5.3	10.5	6.9	3	3	4
McNary	4.7	3.3%	5.3	5.3	6.5	N.A.	N.A.	1.1	1.1	1.3	0.6	0.7	4.8	4.9	28.8	3	3	4
Ice Harbor	2.4	4.7%	2.7	2.8	3.8	N.A.	N.A.	0.9	0.9	1.2	0.6	0.6	3.1	3.0	3.3	2	2	3
L. Monument	2.4	2.9%	2.4	2.5	3.2	N.A.	N.A.	0.6	0.7	0.8	0.4	0.4	4.0	3.7	27.7	3	3	3
Little Goos	2.4	2.6%	2.2	2.4	3.1	N.A.	N.A.	0.6	0.6	0.8	0.4	0.4	3.5	3.7	31.6	3	3	3
Lower Granite	2.4	-0.9%	1.6	1.7	2.2	N.A.	N.A.	0.6	0.6	0.8	0.4	0.4	2.7	2.8	21.6	2	2	3
Wm. Fls Lk-4	N.A.	N.A.	0.5	0.8	N.A.	N.A.	N.A.	1.4	2.1	1.4	0.7	0.7	0.9	12.5	36.1	1	1	1
Guard Lock	N.A.	N.A.	0.3	0.6	N.A.	N.A.	N.A.	1.2	2.0	1.3	0.7	0.6	0.3	13.7	44.9	1	1	1

N.A. = NOT AVAILABLE
SOURCE: Lock Performance Monitoring System (PMS), Corps of Engineers, 1986.

TABLE A-9-5
SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

TOTAL COMMERCIAL NAVIGATION OPERATIONS AND MAINTENANCE ACTUAL COSTS FY 1977-1985 ($000)

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
COL/SNK/WIL										
Col/Snk	2,692	4,927	4,326	5,293	4,688	2,689	7,533	4,357	5,608	8,406
Willamette	423	596	362	1,300	594	657	758	747	510	547
Subtotal	3,115	5,523	4,688	6,593	5,282	3,346	8,291	5,104	6,118	8,953

TON MILES OF TRAFFIC (000) CY 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
COL/SNK/WIL										
Col/Snk	1,416,283	1,138,500	1,200,158	1,398,157	1,491,281	1,316,755	1,337,947	1,424,067	1,051,217	1,210.755
Willamette	23,004	24,516	23,612	23,519	18,641	14,698	12,379	15,550	16,191	17,[illegible]51
Subtotal	1,439,287	1,163,016	1,223,770	1,421,676	1,509,922	1,331,453	1,350,326	1,439,617	1,067,408	1,228,206

O & M COSTS PER TON MILE ($) 1977-1986

SEGMENT/WWY	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
COL/SNK/WIL										
Col/Snk	0.0019	0.0043	0.0036	0.0038	0.0031	0.0020	0.0056	0.0031	0.0053	0.0069
Willamette	0.0184	0.0243	0.0153	0.0553	0.0319	0.0447	0.0612	0.0480	0.0315	0.0313
Segment	0.0022	0.0047	0.0038	0.0046	0.0035	0.0025	0.0061	0.0035	0.0057	0.0073

NOTE: FY 1987 costs in order by the waterway(s) above are 6,568, 798, and the subtotal is 7,366.
1987 Cost/Ton-Mile 's not available because 1987 ton-mile data is not yet available.

SOURCE: Navigation Cost Recovery Data Base System, Corps of Engineers, 1987.

TABLE A-9-6
SEGMENT NUMBER 9
COLUMBIA-SNAKE-WILLAMETTE

STATUS OF CONSTRUCTION, REHABILITATION, AND STUDIES
(Dollars in Thousands)

Waterway and Lock	Status Code	Start Year	Completion Year	Total Cost	User Fund Cost	Allocations Thru FY 88	Percent Complete	FY89 Budget Request
COLUMBIA-SNAKE RIVERS								
Bonneville	CCF	1985	1992	212,000	106,000	33,952	32	42,000
John Day	RC	1980	1983	6,200	0	6,200	100	0
MIDDLE COLUMBIA RIVER (NON FUEL TAXED WATERWAY)								
Locks\Lifts and Channel	SCF	1977	1989	2,276	0	1,829 (1)	80 (2)	0 (2)
Hanford Channel	CINA	Unk	Unk	10,000	0	0	0	0
Priest Rapids	CINA	Unk	Unk	33,000	0	0	0	0
Wanapum	CINA	Unk	Unk	33,000	0	0	0	0
Rock Island	CINA	Unk	Unk	30,000	0	0	0	0
Fish and Wildlife Mit.	CINA	Unk	Unk	4,000	0	0	0	0

(1) Revised scope, developed too late to be reflected in FY 1989 budget request, would require an additional allocation of $241,000 in FY 1988 and an allocation of $206,000 in FY 1989.

SOURCE: See Appendix A, Definitions of Terms, 5, for identification of multiple sources and explanation of status codes.

TABLE A-9-7

SEGMENT NUMBER 9

COLUMBIA-SNAKE-WILLAMETTE

HISTORIC LOCK CAPACITY ANALYSIS

WATERWAY/LOCK NAME OR NUMBER	YEAR OPENED	CAPACITY LOW	CAPACITY HIGH	TONNAGE (millions) 1977	1985	1986	1987	% CHANGE 1977-85	% CHANGE 1977-86	% CHANGE 1977-87	% LOCK CAPACITY USED (1987) LOW(1)	HIGH(2)	LOCK UTILIZATION PERCENTAGE (3) (1987)
Bonneville	1938	12	12	5.8	7.7	8.3	8.9	32.0	43.1	-100.0	0.0%	0.0%	53
Bnnvlle (u const)	1992	32	33							N.A.	468.1%	453.9%	
The Dalles	1957	32	33	4.7	6.3	8.2	9.7	33.0	74.5	106.4	30.3%	29.4%	17
John Day	1968	32	33	4.7	6.2	13.5	9.6	30.0	187.2	104.3	30.0%	29.1%	21
McNary	1953	32	33	4.7	5.3	5.3	37.2	13.0	12.8	691.5	116.3%	112.7%	13
Ice Harbor	1962	32	33	2.4	2.7	2.8	3.9	14.0	16.7	62.5	12.2%	11.8%	17
Lwr Monumental	1969	32	33	2.4	2.4	2.5	22.6	0.0	4.2	841.7	70.6%	68.5%	11
Little Goose	1970	32	33	2.4	2.2	2.4	25.1	-6.0	0.0	945.8	78.4%	76.1%	8
Lwr Granite	1975	32	33	2.4	1.6	1.7	16.0	-34.0	-29.2	566.7	50.0%	48.5%	10
Lock No. 1	1873			N.A.	0.5	0.8	50.8	N.A.	N.A.	N.A.	N.A.	N.A.	53
Lock No. 2	1873			N.A.	0.5	0.8	50.8	N.A.	N.A.	N.A.	N.A.	N.A.	53
Lock No. 3	1873			N.A.	0.5	0.8	50.8	N.A.	N.A.	N.A.	N.A.	N.A.	53
Lock No. 4	1873			N.A.	0.5	0.8	50.8	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Guard Lock	1873			N.A.	0.3	0.6	59.9	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

(1) 1987 tonnage divided by Low capacity value (column 3)

(2) 1987 tonnage divided by High capacity value (column 4)

(3) Performance Monitoring System, Corps of Engineers, 1987

THE 1988 INLAND WATERWAY REVIEW

APPENDIX B

DESCRIPTION OF ENVIRONMENTAL PLANNING

FOR

INLAND WATERWAYS

OPERATION AND MANAGEMENT

I. GENERAL OVERVIEW

This appendix briefly describes selected environmental planning considerations for the effective management of the Nation's inland waterway system. The purpose of this appendix is to provide a very basic description of the key legislative and policy requirements, planning principles, and potential environmental issues. This appendix is not to be construed as a NEPA document. Furthermore, the Corps is in the process of developing a regional navigation investment planning system which will address: (1) the physical condition of the inland waterway infrastructure; (2) problems and needs; and, (3) strategies for prioritizing capital investment decisions.

From a national perspective, the Corps manages a complex system of locks and dams which provides an economic and energy saving mode for transporting bulk commodities over long distances. Commercial and recreational traffic is integrated with other multipurpose objectives, such as, flood control, water supply, hydropower generation, and resource management.

Since the passage of the National Environmental Policy Act in 1969, the Corps has responded with a heightened concern for ecological and environmental values as part of its decision-making process. Within the national inland waterway system are several key component systems where environmental work is carefully managed on a project-by-project basis to account for unique and critical resources. Environmental work is thereby decentralized and responsibility falls on district engineers to comply with legal requirements and to coordinate with other Federal and State agencies. This decentralization helps ensure that environmental standards set down by Congress are met.

II. LEGISLATIVE OVERVIEW

The U.S. Army Corps of Engineers has incorporated vigorous environmental analysis into its planning, design, construction, and operation and maintenance of projects in accordance with Council on Environmental Quality (CEQ) regulations for implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) (40 CFR 1500-1508). Thus, environmental impacts are considered at every step in the life of a project, from planning, engineering and design, through construction, and operation and maintenance. The Corps works closely and in conjunction with State agencies to provide the public with information and to secure ample public input. The Corps also implements the Sections 404 and 10 permit program to regulate the discharge and movement of dredged and fill material, and structures in navigable waters, respectively.

The following list of statutes and executive orders and memoranda illustrates the importance of environmental management for Corps studies and projects. Regardless of whether or not the Corps produces a NEPA document, the following environmental regulations must be followed.

STATUTES

Archeological and Historic Preservation Act
Archeological Resources Protection Act
Clean Air Act
Clean Water Act
Coastal Zone Management Act
Endangered Species Act
Estuary Protection Act

Federal Water Project Recreation Act
Fish and Wildlife Coordination Act
Land and Water Conservation Fund Act
Marine Protection, Research and Sanctuaries Act
National Historic Preservation Act
National Environmental Policy Act
Rivers and Harbors Act
Watershed Protection and Flood Prevention Act
Wild and Scenic Rivers Act
Farmland Policy Protection Act

EXECUTIVE ORDERS AND MEMORANDA

Floodplain Management (E.O. 11988)
Protection of Wetlands (E.O. 11990)
Analysis of Prime and Unique Farmlands
Protection and Enhancement of the Cultural Environment

A. COMPLIANCE WITH NEPA

In conjunction with CEQ regulations (40 CFR 1500-1508), the Corps has established internal procedures for implementing NEPA which are applicable to all HQUSACE elements and all Field Operating Agencies (FOAs). These regulations are intended to supplement CEQ rules in accordance with 40 CFR 1507.3. At the core of the process is the district commander who is responsible for compliance with NEPA regulations and preparing agency documents on environmental matters. Actions normally requiring an Environmental Impact Statement (EIS) are as follows:

1. Feasibility reports for authorization and construction of major projects;

2. Proposed changes in projects which increase size substantially or add additional purposes; and,

3. Proposed major changes in the operation and/or maintenance of completed projects.

If studies and coordination indicate that the above cited actions are not likely to have a significant impact on the quality of the human environment, district commanders may use an Environmental Assessment (EA) in place of the EIS. The EA is designed to describe the potential environmental effects of a proposed action and its alternatives leading to the EIS or a Finding of No Significant Impact (FONSI). A FONSI is prepared for actions in which an EIS is not anticipated.

Other actions which normally require an EA and not necessarily an EIS are as follows:

1. Regulatory Actions. The Corps Sections 10 and 404 permits.

2. Authorized Projects and Projects Under Construction. This would include changes in such projects using the Secretary's discretionary authority.

3. Continuing Authorities Program. In the case of navigation, this would include projects recommended for approval of the Chief of Engineers under such authorities as: Section 107, Small Navigation Project Authority; Project Authority; and Section 111, Mitigation of Shore Damages Attributable to Navigation Projects.

4. Construction and Operations and Maintenance. This would involve changes in environmental impacts not considered in original EIS or EA. For example, changes in the location of bank protection works.

5. Real Estate Management and Disposal Actions. The disposal of real property for public port and industrial purposes would be included in this category.

Some actions are categorically excluded from NEPA documentation. By regulation and definition, these actions typically do not have individual or cumulative significant effects on the quality of the human environment. However, extraordinary circum-stances may require the preparation of an EA or EIS.

Selected examples of categorical exclusions are:

1. Actions at completed projects which carry out the authorized project purpose. For example, routine operation and maintenance and rehabilitation. Also included in this category would be replacement of existing structures and facilities such as levees and roads and work on erosion control.

2. Minor maintenance dredging. This would involve the use of existing disposal sites.

3. All operation and maintenance grants, general plans, agreements, etc. These grants or agreements are necessary to carry out measures proposed in project authorization documents, project memoranda, and master plans, or reflected in project NEPA documents.

Additional examples of categorical exclusions are described in 33 CFR 230.9.

B. ENVIRONMENTAL PLANNING PRINCIPLES

The Corps of Engineers planning principles incorporate the Federal objective as stated in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources (P&G). This objective mandates that project planning must contribute to national economic development consistent with and pursuant to national environmental statutes. The Corps, in carrying out its civil works program, has advanced a vigorous effort to comply with environmental statutes and promote the protection and enhancement of the quality of the environment. This effort is evident in all aspects of planning and implementation, underlining a strong commitment to a rigorous environmental protection program.

Environmental concerns may evoke difficult and complex political, social, and economic issues that must be addressed during project planning. Typically, the Corps addresses environmental concerns in an open atmosphere seeking public involvement in the early stages of planning studies. This open planning process assures that project managers strive to balance environmental, economic, and engineering needs.

During the reconnaissance phase, a preliminary identification of significant resources and possible environmental problems is accomplished. During the feasibility phase, a detailed NEPA document is prepared assessing the environmental effects of alternatives, including measures to avoid or minimize effects. During coordination with other Federal agencies such as the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS) and the appropriate State natural resource agencies, the Corps documents specific enhancement and mitigation plans, if required.

During the engineering and design phase, environmental factors are reviewed for appropriateness, and any design changes are examined for environmental sensitivity. NEPA and

Corps regulations require that significant environmental effects not identified during feasibility planning are addressed during Preconstruction Engineering and Design (PED) and development of Plans and Specifications (P&S).

At each step in the process, environmental assessments and environmental impact statements are reviewed, and, if required, revised or supplemented. During construction, significant efforts are made to minimize effects by ensuring that environmental concerns are properly handled. Once a project is completed, the operation and maintenance plans also may require following specific environmental guidelines to achieve a balance between project multipurpose uses including environmental quality. Followup environmental reviews are conducted.

III. NAVIGATION

For Corps elements having significant navigation mission, extensive efforts are made to ensure effective coordination among Corps offices, other districts and divisions, the public, and State and Federal agencies. Brochures and public information meetings are routinely held, and numerous professional meetings and conferences serve as information dissemination mechanisms for Corps staff. It is common practice for Corps divisions to establish information exchange vehicles such as meetings, computer mail systems, and newsletters, to supplement the more national perspective oriented information disseminated by headquarters staff.

The successful execution of a complex coordination program can be illustrated by looking at the Upper Mississippi River System (UMRS) which falls under the jurisdiction of the North Central and Lower Mississippi Valley Divisions, and their three Districts (NCR, NCS, and LMS). Current UMRS activities include: (1) the Environmental Management Program; (2) major maintenance; (3) the second lock at Lock and Dam 26; (4) ramp-up for proposed FY 90 navigation planning studies; (5) preparation of an EIS on the cumulative effects of selected major rehabilitation measures; and, (6) the establishment of a Navigation System Support Center (NSSC) at the Rock Island District. The various Corps elements routinely exchange information on these navigation related activities. Commanders conferences have been held, reports and other documents are exchanged for information and comment, and under the auspices of the NSSC, a navigation newsletter will be published. Furthermore, a number of technical committees, work groups, and task forces have been established comprised of Corps, U.S. Fish and Wildlife Service, State, and private organization staff members to coordinate a variety of environmental matters.

The Ohio River Division has a similar coordination network established, albeit the projects, players, and issues are somewhat different. The successful execution of navigation related work by ORD and its technical support centers is one model for other inland waterway components. Overall, environmental matters related to navigation are well coordinated and efforts such as the various task forces established through Planning Division, Directorate of Civil Works, Office of the Chief of Engineers, have helped improve coordination and information exchange even further. Furthermore, the Environmental Newsletter issued by the Office of Environmental Policy has proven to be an effective tool for disseminating information related to navigation and the environment.

A. CONSTRUCTION

The construction of projects (i.e., levees, dikes, boat dock facilities, locks and dams) may affect water quality and aquatic and terrestrial habitats. According to Corps and EPA studies, construction may cause increased sedimentation and loss or elimination of habitat. Effects are defined by the size and duration of construction schedules as well as site conditions and environmental features. For example, sediment contamination may result from pesticides and

fertilizers used at the site. Fuels and solvents, as well as metals and other chemicals, may leak. However, for most construction projects, the use of ible contaminants is well regulated to avoid problems. In addition, erosion caused by t tural characteristics as well as the earthmoving operations of a construction project, impact water quality and habitats. Typically, contractors will take steps to avoid sig. ficant erosion problems and many projects require habitat replacement or restoration work.

Studies have shown that downstream impacts, caused by the reductions in the concentration of dissolved oxygen in the water and increases in turbidity, are relatively short-term and the aquatic habitat can recover.

B. OPERATION OF LOCKS AND DAMS

When waters are impounded, as in the case of locks and dams, the reduction in turbulence and velocity of water may cause an increase in sedimentation. Dam operations can also contribute to a seasonal decrease in dissolved oxygen values within the pool above the lock and dam. This is primarily due to the greater depth area/volume ratio which cause decreases in reaeration. The increased volume of water, accompanied by lower velocities and less turbidity, promote the growth of planktonic algae. Corps studies have cited the positive effects of aeration from the release of waters from the impoundment to the downstream portion of the river. However, such studies also point out that the increases in nitrogen from reaeration and in turbidity can reduce the value from gate operation.

With regard to lock operations, Corps studies have found no significant impact on the physical parameters downstream and the related aquatic biota. There are minor impacts from hydraulic effects in the proximity of a lock. These effects cause some suspended materials to settle out of the water column, but the effects to aquatic biota are considered insignificant.

Lock and dam operation may affect water temperature and flows. Impoundments can also create new open water wetlands and backwater habitats. They also favor the growth of planktonic algae which in turn may cause an increase in the fish population. The reduced flow velocity usually results in changes in the types of aquatic organisms, from those requiring strong currents and high dissolved oxygen concentrations, to those adapted to or that are tolerant to slow moving warmer water and lower dissolved oxygen regimes.

It is evident from many studies that lock and dam operations may have impacts on water quality and aquatic habitats. Many of these impacts are positive, such as increased dissolved oxygen levels and migration channels for movement of species between pools. Correspondingly, Corps studies have identified various structural and nonstructural methods for preventing some of the negative impacts and minimizing those that cannot be averted.

C. NAVIGATION TRAFFIC

Commercial and recreational traffic may cause direct and indirect environmental effects. Navigation projects, which include the construction of locks, dams, ports, river training improvements (such as levees and dikes) as well as barge fleeting and loading facilities, may involve environmental issues of public concern. Consequently, the development of the waterways, including the operation and maintenance of the navigation structures and dredging on the waterways, must continue to be managed proactively to avoid or minimize effects which may stress ecological systems.

Recent workshops conducted by the Waterways Experiment Station have set out to organize and assess the Corps understanding of the impacts of commercial navigation traffic on the

environment. WES staff contend "that incremental increases in commercial navigation traffic are unlikely to cause negative effects to significant biotic resources in large waterways." This contention will continue to be evaluated through additional studies and conferences prior to any final conclusions. Impacts will vary depending on the direction the vessel is heading, its speed, draft, and other operating characteristics, as well as conditions of the waterway, depending on the season of the year and the nature of its aquatic habitats.

The movement of boats and tows can have an impact on water quality as well as terrestrial resources and aquatic habitats. One such impact is the resuspension of sediments which affects water quality, increases turbidity, and thereby affects aquatic habitats. Corps studies have shown that impacts depend on such variables as vessel size, speed, depth of the channel, and the characteristics of the channel bottom. Wave activity from boat and tow movements can also have environmental impacts through erosion in shore areas and banks. Such aspects as wave wash can affect shore-dwelling animals and cause erosion, impacting wetland vegetation. Other impacts may come from commercial and industrial traffic carrying hazardous commodities and the threat of pollution from waste discharge and spills.

Increased levels of navigation may increase the magnitude of the physical effects, such as turbidity, the erosion of streambanks, and sediment resumption. Simons, et al. (1988) have determined, however, that resuspended sediments resulting from tow traffic would have little effect on the expected physical life of backwater areas and side channels. Physical impacts could be greatest in areas that have a narrow channel width, large sinuosity, short distance from the sailing line to the bank, frequent dredging requirements, and high erosion potential. The biological implications of these physical effects include loss of habitat: loss of biological productivity, diversity, and abundance; and disruption of the normal behavior patterns. Specific impacts on some organisms are unknown.

Recreational boats can also generate physical changes when they operate near shore and in side channel and backwater areas. These physical alterations may result in adverse biological effects primarily caused by increased turbidity and suspended sediment levels, degradation of water quality, and increased shoreline erosion. The degree and magnitude of these physical disturbances can be estimated; however, the specific biological impacts are not well understood.

D. DREDGING AND DREDGED MATERIAL PLACEMENT

The U.S. Army Engineer's Waterway Experiment Station at Vicksburg has conducted numerous studies on the environmental effects of dredging and dredged material placement. Dredging and dredged material placement can have both significant physical and biological effects, particularly if the sediments contain toxic substances. The Corps is generally able to predict these effects and define the management options for minimizing adverse effects. Dredged material placement often creates the greatest problem for both technical and political decision-making.

Dredging, or the removal of bottom material, impacts flow velocities and volumes may alter the local hydraulic conditions which support the aquatic habitat in critical river reaches. Changes in sediment composition, along with the removal of benthic organisms and the generation of suspended sediment and turbidity, all have an impact on water quality and the aquatic ecosystem. The degree of impact is related to the nature of the dredging operation, the environmental conditions present at the site, and the nature of the material dredged.

The dredged material management program is complex from an environmental perspective because its effects may occur both during dredging itself and during placement. The large number of studies conducted by the Corps has clarified technological, scientific, and ecological

considerations. While coastal dredged material management is becoming well known, there is still much to learn about the dredged material management programs for some inland waterways segments. The Corps will continue to study the environmental, economic, social, and political implications of the dredged material management program.

IV. RELATED STUDIES

The Institute for Water Resources solicited comprehensive bibliography on environmental matters, related to navigation, from all Corps districts and divisions. A substantial amount of information was collected on a diverse number of topics, pointing out the need for the Corps to consider the establishment of a Nationwide data base for bibliography. Such a data base, perhaps annotated and available via ONTYME, would improve information exchange and facilitate topic or regional specific literature searches.

The information supplied to IWR focuses on studies conducted within the last 5 years, those currently underway, and those programmed for the future. This information revealed the varied and comprehensive nature of the Corps work in natural resource management and research. Studies for dredged material management, long-term habitat change, revegetation, fisheries, water quality, wildlife and environmental management are only a few examples of Corps efforts to promote a consistent stewardship ethic for the conservation of environmental resources. The lists of sources compiled by IWR will be compiled and furnished to the field for information purposes.

Studies on Commercial Navigation Traffic Effects

The U.S. Army Engineer Waterways Experiment Station is conducting laboratory and field studies on commercial navigation traffic effects. The purpose of this work is to determine if the physical effects of commercial traffic (cyclic periods of turbulence, wave wash, elevated suspended solids, etc.) can have a detrimental effect on freshwater biota. Parameters that are measured to indicate stress are at the individual species level (physical and physiological condition indices), population level (evidence of recent recruitment, density, growth and mortality), and community level (species diversity and richness).

The following is a brief synopsis of laboratory and field studies:

Field Studies

1. Effects of commercial navigation traffic in a barge turning basin in the upper Mississippi River near Prairie du Chien, Wisconsin, on density and evidence of recent recruitment of freshwater mussels (1984 - present).

2. Effects of commercial traffic near a navigation channel on the lower Ohio River on growth and mortality of freshwater mussels (1983 - present).

3. Effects of cessation of barge traffic on sediment resuspension on the lower Tennessee River near Paducah, Kentucky (1986).

4. Effects of barge passage on larval fish mortality in the upper Mississippi River near La Crosse, Wisconsin (1986).

5. Effects of barge passage on community and population parameters of aquatic insects and sedimentation rates in a backwater lake in the upper Mississippi River (1985 - present).

6. The UMRS Environmental Management Program, managed by the North Central Division, is conducting field studies to provide (a improved data for existing predictive models on the physical effects of shear and turbulence caused by movement of tows and (b) predictive models for the assessment of tow-induced turbidity and sediment movements. These data collection efforts and other efforts under the Long-Term Resources Monitoring (LTRM) component will contribute valuable information for navigation studies and management.

Laboratory Studies

1. Effects of turbulence, elevated suspended solids, and desiccation on selected species of larval fishes (including an evaluation of delayed mortality).

2. Effects of turbulence, elevated suspended solids, and desiccation on selected species of freshwater mussels.

3. Development of a software system to provide information on the effects of commercial navigation traffic.

4. Development of a model that relates effects of commercial traffic on suspended solids to feeding rates of freshwater bivalves.

5. An analysis of the use of physiological condition factors to evaluate commercial navigation traffic effects (1986 - present).

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